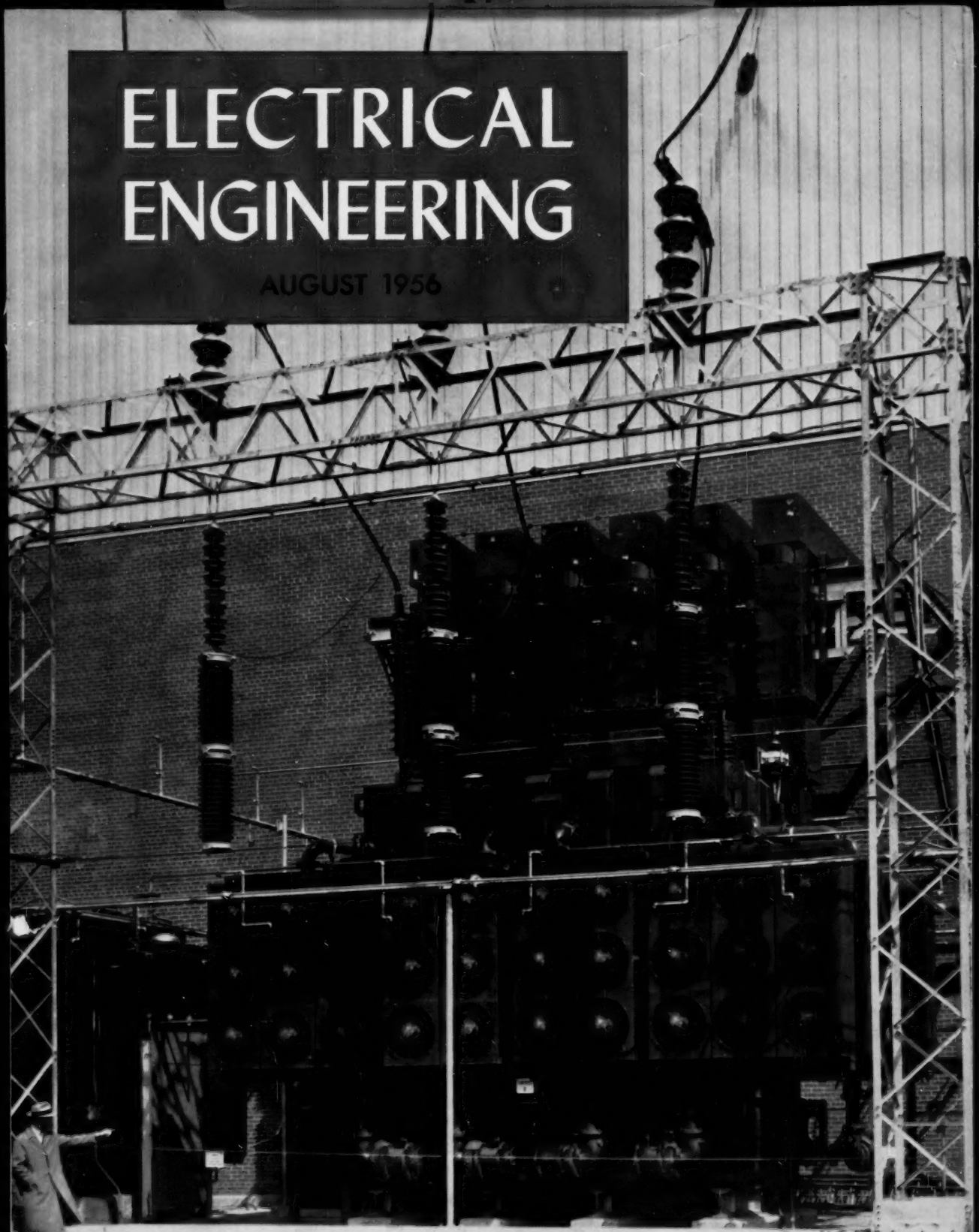
ELECTRICAL ENGINEERING

AUGUST 1956



PRESENT AND FUTURE TELEPHONE TRANSMISSION • DYNAMAX, NEW MAGNETIC CORE

ENGINEERING AND MANPOWER SHORTAGES • 230-KV GAS BLAST SWITCH TESTS

AIEE BOARD OF DIRECTORS REPORT

Advanced Design

Means: Reduced Weight / Easier Handling / Versatile Installation

Advanced design features make these Allis-Chalmers potential transformers smaller and lighter than ever before. This reduction in size and weight results in space-saving transformers that are easier to handle and simpler to install.

NEW compact design also results in improved performance in both ratio and phase angle.

NEW potential transformer ratings have been added to include higher voltage classes.

Best of all, with these smaller, lighter units, you still get all the maintenance-cutting, long-term economy features you expect from Allis-Chalmers.

ALLIS-CHALMERS Potential Transformers

POTENTIAL			
Two-Bushing Transformer			
TYPE	Insulation Class	Height	Weight
SPW-2	25	38½	280
SPW-3	34.5	40½	310
SPW-4	46	48½	615
SPW-6	69	61	1160
SPW-11	115	86	3400
Single-Bushing Transformer			
SPW-21	25	41	260
SPW-31	34.5	44¼	285
SPW-41	46	50¾	460
SPW-61	69	63¾	950
SPW-111	115	92	2310
SPW-131	138	112	3510

Get all the information on these modern lightweight transformers. Contact your nearby A-C district office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

LIVE BETTER ELECTRICALLY

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5125

ELECTRICAL ENGINEERING

AUGUST 1956
Vol. 75, No. 8

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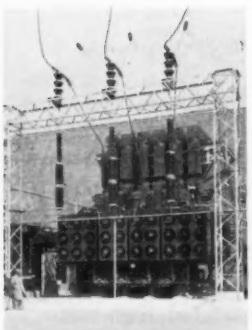

THE COVER: This 315,000-kva, 17.3/129-kv, the world's largest generator transformer installed, was built by Westinghouse Electric Corporation. The three-phase forced oil-to-air cooled unit is the first of two identical ones being built for the Number 1 and Number 2 units of Detroit Edison Company's River Rouge Power Plant. The second will be installed late in 1956. The transformer weighs 448,000 pounds installed and is 24 1/2-feet high (from foundation to bushing tips), 16 3/2-feet wide, and 26-feet long.

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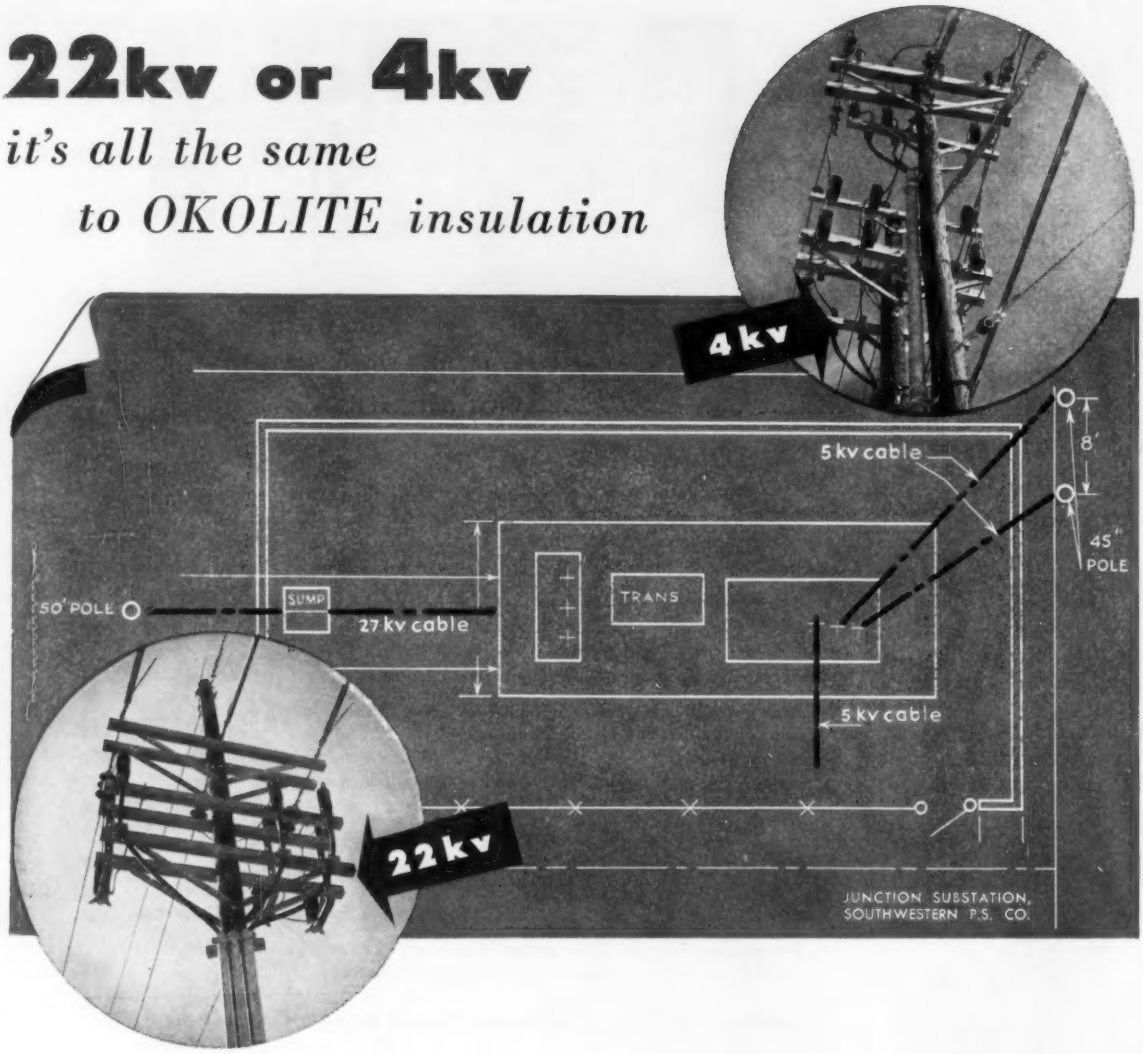
22kv or 4kv

it's all the same to OKOLITE insulation



High voltage or low voltage—Okolite rubber insulation provides maximum dependability and utmost safety. Here at the Junction Substation of the Southwestern Public Service Company in Lubbock, Texas, both the 4kv and 22kv circuit risers are Okolite-insulated, Okoprene-sheathed cables.

Okolite-Okoprene cables have an outstanding reputation for reliability in circuits up to 35,000 volts. Okolite-Okoprene is easy to handle and cuts installation costs; the problem of oil migration is nonexistent and splices and terminations require less time and labor.

Write today for Okonite's complete handbook on rubber-insulated, high-voltage cables, Bulletin EG-1075. It contains complete engineering and installation information for circuits up to 35,000 volts. The Okonite Company, Passaic, N. J.

OKONITE insulated cables

2304

For more information circle 1 on reader service card.

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West Coast Adv. Office
635 S. Kenmore Ave.
Suite 201
Los Angeles 5, Calif.
Tel: DUnkirk 5-3991

M. R. Rodgers
Advertising Production Manager

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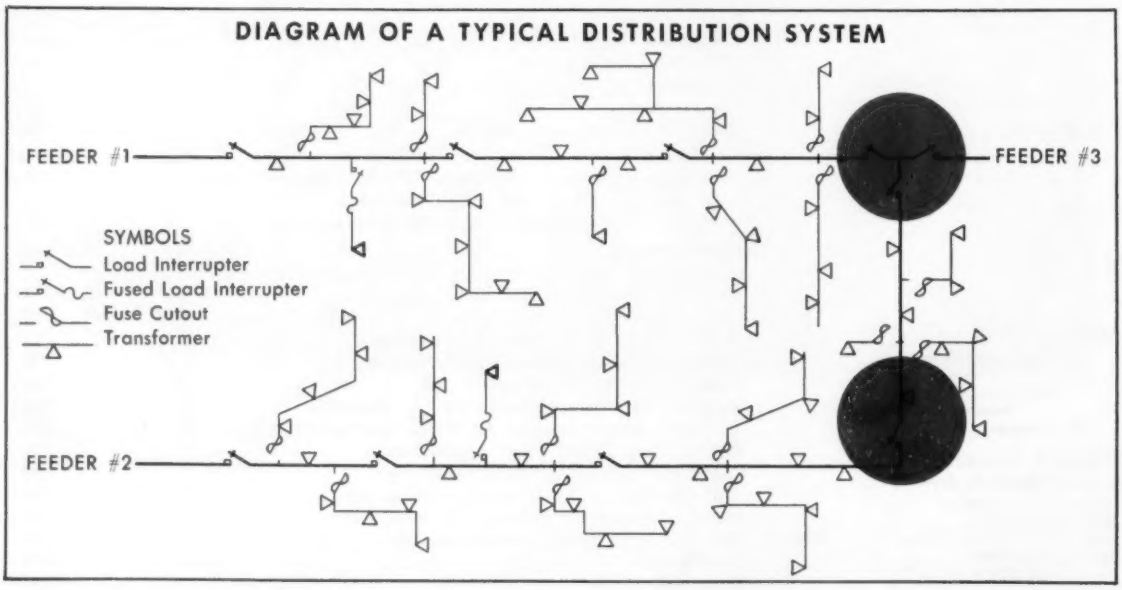
ARE BIGGER LOADS BRING IN SWITCHING YOUR 12 KV

With S&C Load Interrupters you can handle *all* switching duties on a typical distribution feeder—any load current, charging current, or magnetizing current.

With conventional disconnects or horn gaps, higher voltages and higher currents can mean serious trouble. With the S&C Load Interrupter there is no external arc, no danger of flashover, no hazard to personnel, no uncertainty. It can open the circuit *under any condition* except short circuit.

Whether your switching problem is at a feeder tie (see illustration below), at a sectionalizing point on a feeder, or at a branch tap, the S&C Load Interrupter will give you safe, positive, circuit interruption.



Typical application of S&C Load Interrupters (symbol) on distribution feeders. Circled in blue are specific cases—feeder tie points. Even here increased loads have made switching difficult in spite of the fact that parallel circuits are easier to open. Load Interrupters may be opened or closed on full line voltage and full load current—a real advantage during emergency conditions and a definite convenience under *normal* circumstances.

LOAD INTERRUPTER

Specialists in High-Voltage Circuit Interruption since 1910

S&C ELECTRIC COMPANY

4427 RAVENSWOOD AVENUE • CHICAGO 40, ILLINOIS, U. S. A.
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POWER FUSES • DISTRIBUTION CUTOUTS AND FUSE LINKS • LOAD INTERRUPTERS • METALCLAD SWITCHGEAR

ING BIGGER HEADACHES DISTRIBUTION FEEDERS?

Performance Comparison of Switching Devices

PERFORMANCE	S&C Load Interrupters		Conventional Disconnects	
	Stick-Operated	Group-Operated	Stick-Operated	Group-Operated
Interrupt current from parallel sources safely?	YES	YES	DOUBTFUL	DOUBTFUL
Safe to equipment or personnel if inadvertently opened on full voltage (in case loop is open)?	YES	YES	NO	DOUBTFUL
Dump load without opening feeder breaker, or without preliminary unloading?	YES	YES	NO	DOUBTFUL
Multi-pole device controllable from ground (may be required by system practice or other circuits on same pole)?	NO	YES	NO	YES
Simple to install?	YES	NO	YES	NO
Cost?	LOW	HIGHEST	LOWEST	HIGH

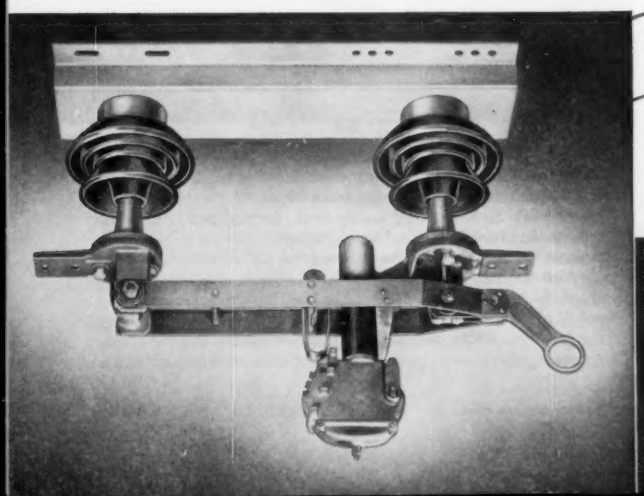
ABOUT THE S&C LOAD INTERRUPTER

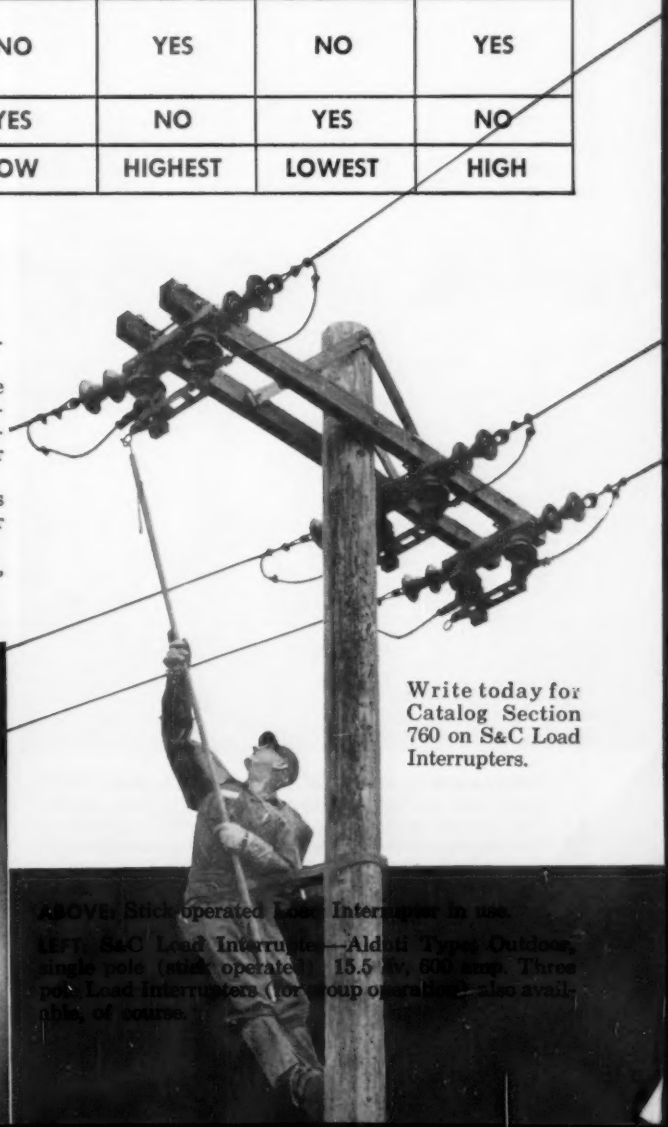
It can switch the circuit without unloading preliminaries and without opening the main breakers.

Switching cannot lead to dangerous phase-to-phase or phase-to-ground faults, because there is NO EXTERNAL ARC. Hence, there is no danger to men or equipment, even in case of inadvertent operation under emergency conditions.

It interrupts all load currents and charging currents instantly, making a clean, decisive break. The operator doesn't have to "dog" it.

It can be mounted in any desired position—vertical, upright, or inverted.





Write today for Catalog Section 760 on S&C Load Interrupters.

ABOVE: Stick-operated Load Interrupter in use.

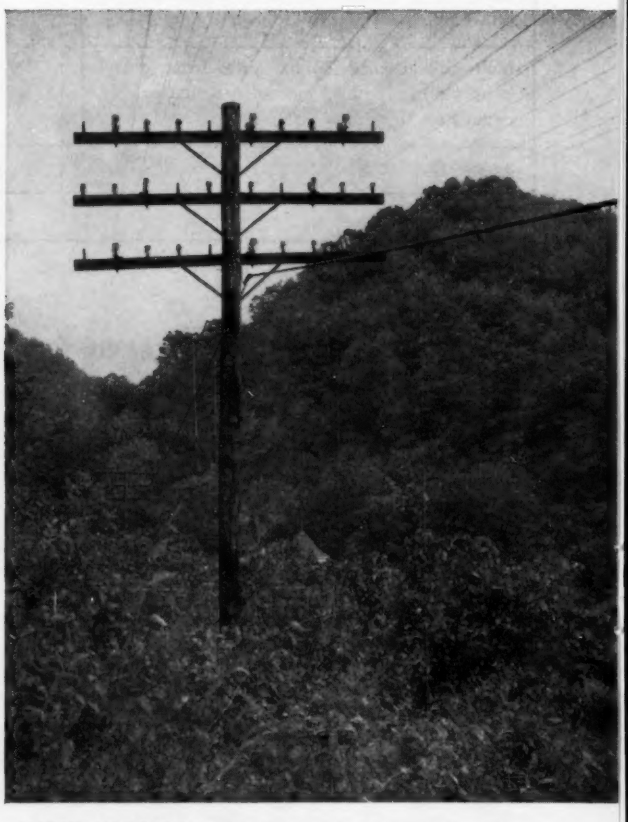
LEFT: S&C Load Interrupter—Alduti Type Outdoor, single pole (stick operated) 15.5 kv, 600 amp. Three pole Load Interrupters (for group operation) also available, of course.

Telephone installations show . . .

Where Polyethylene brings savings

INDIANA—A substantial saving in poles is evident in this rural area. The light weight of cable covered with polyethylene permits smaller poles, longer spans, faster installations. In many cases, cable can be strung without a messenger. Splicing has been greatly simplified.

The polyethylene covering has been found highly resistant to ice formation during the sleet storms common to northern Indiana. Where underground installations are made, polyethylene has eliminated the problem of electrolytic action in the soil. Installations in the near future will have much of this cable plowed underground, at a considerable saving.



WEST VIRGINIA—Installation of additional lines here in the mountains is a costly undertaking. Steep slopes overgrown with trees and brush make rights-of-way practically inaccessible to motorized equipment. In addition, holes for poles must often be blasted through rock.

Most of these problems are solved by distribution wire covered with lightweight polyethylene, now used almost exclusively in this area. This cable can be strung on existing poles, often without adding crossarms. Where lines are strung along railroads and near coal preparation plants, the chemical-resistant polyethylene promises protection from chemical fumes.

For more information circle 3 on reader service card.

These field reports from the telephone industry may help you evaluate the economies possible with polyethylene-insulated cable in your own installations. Taken together, they represent many years of experience with BAKELITE Brand Polyethylene under a variety of terrain and climatic conditions.

The light weight of this insulation has saved time and effort in installation; in fact, some installations would have been next to impossible with earlier materials. The moisture resistance of polyethylene has minimized weather hazards, while dielectric strength has far exceeded telephone requirements. The strength and flexibility of polyethylene have simplified cable handling.

In addition to telephone applications, BAKELITE Polyethylene is extensively used in utility line wire and service drop, power cable, coaxial cable, and signal control cable. Besides satisfying REA requirements for plastic-covered telephone wire, it meets applicable IPCEA specifications for power cable, ASA standards for weatherproof wire, ASTM D1238-52T Type II, dielectric materials, and IMSA specifications for fire alarm and signal control cable. For more information, write Dept. RH-55.

BAKELITE
BRAND
Polyethylene Plastic

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.
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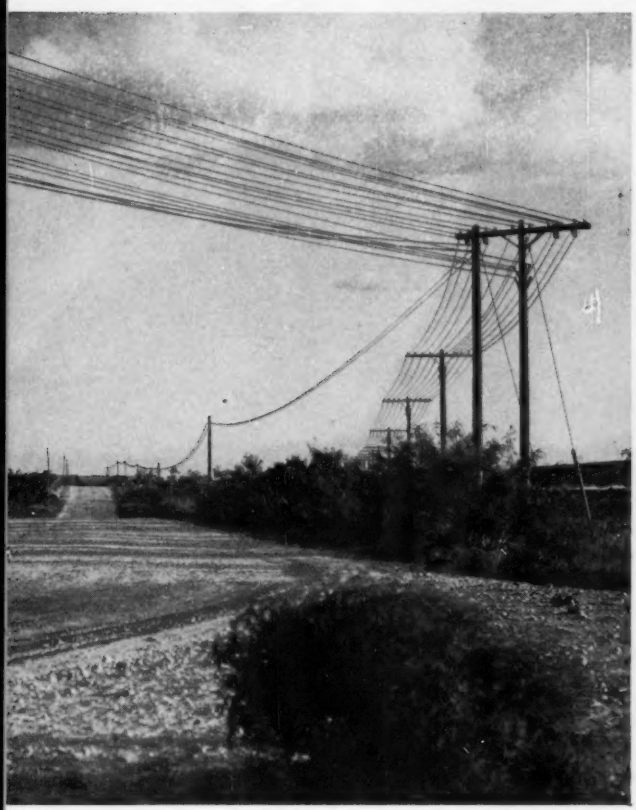
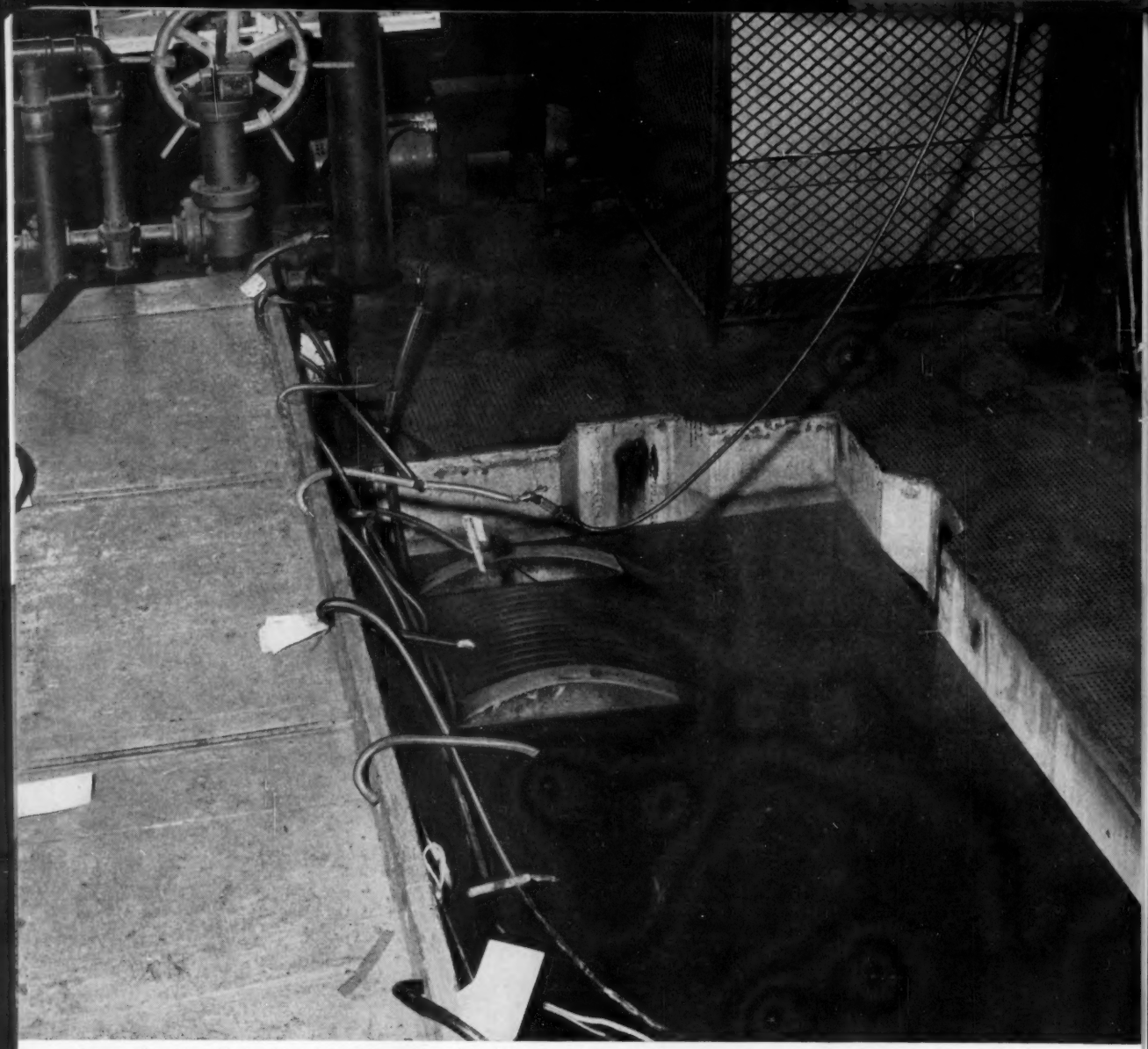


TEXAS—These parallel telephone lines illustrate the savings possible with polyethylene-covered cable. Here, the new lines require ⅓ fewer poles as a result of the extremely light weight of the polyethylene.

Over a million pair-feet of polyethylene-covered cable are in service, and 70 million more are on order for this section, where climate ranges from semi-tropic to semi-desert. The polyethylene jacket must withstand heat, cold, wind, icy and arid conditions. When cable is placed underground, as in urban areas, the polyethylene resists corrosion by stray electric currents in the earth.

VIRGINIA—This terrain combines steep slopes and meadowland, much of it covered by sharp rocks. Problems include the difficulty of placing poles, the need to use only "overhead" rights-of-way at many points, and possible damage to ordinary cable covering if it comes into contact with the stony ground.

Under these circumstances, the lighter, tougher, more flexible polyethylene-covered cable was a distinct advantage. It permitted longer spans to stretch from hill to hill without poles in the fields. It was strung through blocks on the messenger in sections impassable to trucks. There was never any danger of its sagging to the ground and being cut on the rocks.



Anaconda 15-kv cable is subjected to 106 kv — 33% above industry standards with d-c. And tested at 25% above industry requirements with a-c.

15-KV CABLE GOES

Skin diving at 106 kv

Anaconda Type AB butyl-insulated high-voltage cable is tested under water at 600% overvoltage to assure you peak performance.

The fact that two high-voltage cables may look alike does not mean they'll perform alike. At Anaconda, 15-kv cable is tested at 106 kv with d-c for fifteen minutes. This voltage is *33% above industry standards with d-c.* And in addition, Type AB is tested at 25% *above industry requirements with a-c.*

Only a vastly superior insulation can stand such high test voltage, even though there is no defect in the cable.

For your assurance of maximum service, Anaconda butyl-insulated cables are designed to perform far beyond industry requirements — in every important electrical and physical property.

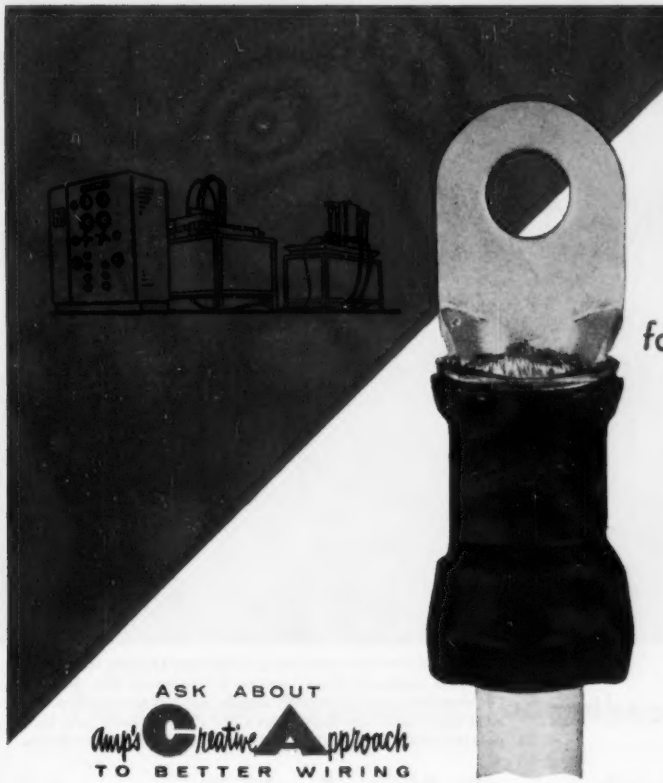
New Engineering Bulletin EB-27 gives you full details on performance of Type AB insulation in 15 Industry Specification tests. Ask the Man from Anaconda for your copy. Or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y. 56294

Get all the facts on Anaconda Butyl. Write today —

SEE THE MAN FROM ANACONDA®

pioneer in **BUTYL INSULATION**

For more information circle 4 on reader service card.



Ampli-Bond Trade-Mark

PRE-INSULATED TERMINALS

for heavy-duty wires!

Ampli-Bond is the first and only terminal with bonded insulation and insulation support for copper wire sizes 8 through 4/0.

ASK ABOUT
Amp's Creative Approach
TO BETTER WIRING

Bonded insulation, withstanding a minimum of 6000 volts, insures dielectric value. . . . An insulated metal reinforcing ring grips the insulation and protects the wire from the weakening effects of vibration and bending. . . . The terminal body is electro-tinned for high conductivity, and the dimpled inner barrel increases the contact surface and tensile strength. . . . Assures low millivolt drop.

The A-MP Dyna-Crimp Tool, with interchangeable heads and dies, crimps Ampli-Bond terminals rapidly, easily and uniformly.

Consult your local A-MP Sales Engineer or write to Harrisburg for further information.

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AMP

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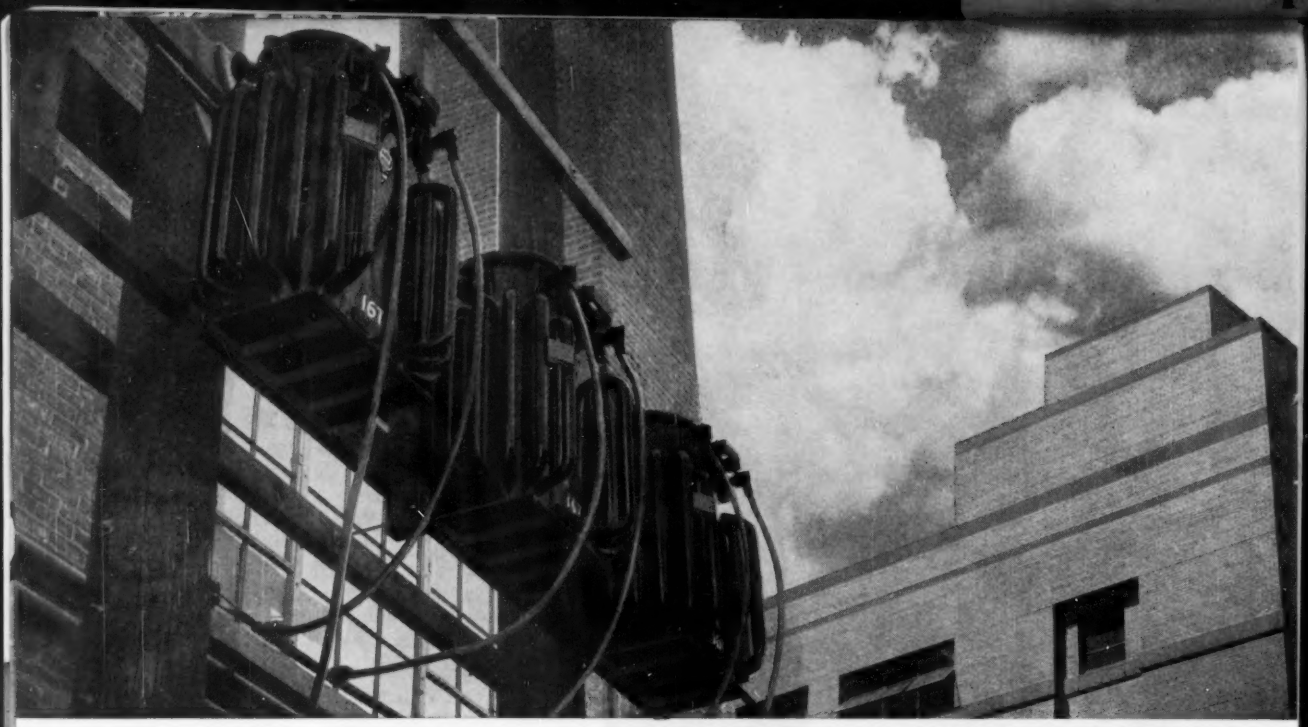


L-M's Round-Wound transformers provide more capacity for heavier short-time overload without sacrifice in transformer life. Because L-M's obround design is lighter, smaller, and has less bending moment than round tank design, three 167's can be hung on a two-pole structure in place of three 100 kva transformers of older design.

For Heavier Commercial Loading

Why L-M Round-Wound® Transformers

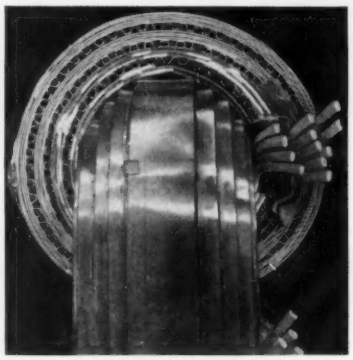
Core-type construction with cruciform cross-section core and round coils provides the most efficient design for lower hot-spot gradient, greater capacity for short-time overload.

By **ROBERT P. THOMPSON**
Manager of Engineering
Transformers
Line Material Company

One of the primary factors that limit the overload capacity of a transformer is the efficiency with which heat from the coils can be dissipated into the transformer oil. Particular care was taken, therefore, in the design of L-M Round-Wound transformers, to assure greatest exposure of coil surface area to cooling oil, and least obstruction to oil circulation.

Cruciform Cross-Section Core

The core is wound of a continuous strip of oriented steel, of varying widths, to form a core of nearly round cruciform cross section. The cruciform cross section of the core provides natural oil passages for cooling between core and coils.



Natural oil passages between cruciform core and round coil help to dissipate the heat from the coils more rapidly. In addition, ducts between windings and between layers in most sizes provide additional oil circulation.

Round Coils and Cooling Ducts

L-M's long round coils expose a relatively large and highly efficient area to cooling oil. Because of this, they provide greater overload capacity than rectangular coil types. In addition, ducts are provided for oil passages between windings and between layers in most sizes, giving exceptionally uniform cooling for the coils.

Core-Type Construction

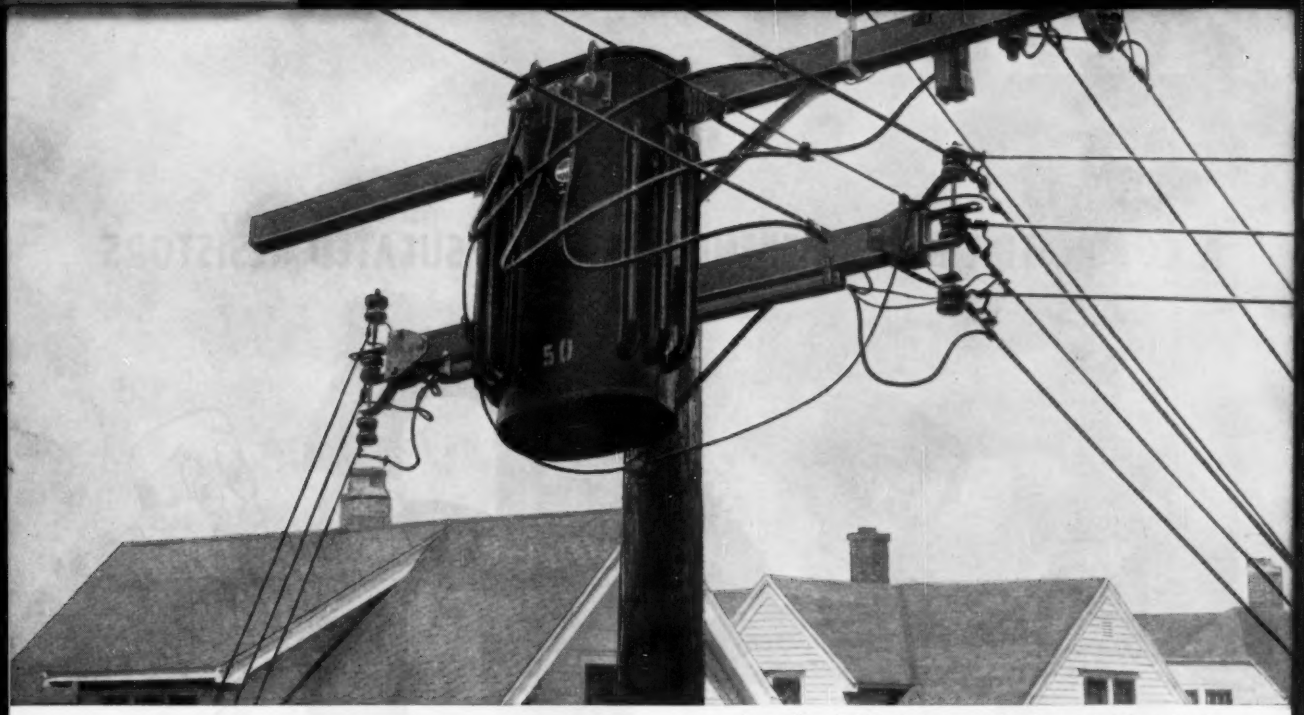
In comparison with shell-type construction, L-M's core-type Round-Wound transformer has greater outer coil surface exposed to cooling oil; therefore coils are cooled more rapidly and uniformly. The cooling surfaces of shell types are partly blanketed by core steel; oil circulation is more obstructed.

Lower Hot-Spot Temperature, Higher Overload Capacity

Because L-M's Round-Wound design provides more efficient dissipation of heat from the coils to the oil, it has appreciably lower hot-spot temperatures during overload. This permits higher short-time overload, or longer overload periods, or greatly increased over-all life of the transformer.

LINE MATERIAL
A McGRAW ELECTRIC COMPANY DIVISION

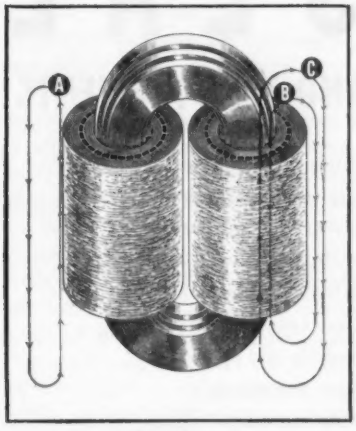
For more information circle 6 on reader service card.



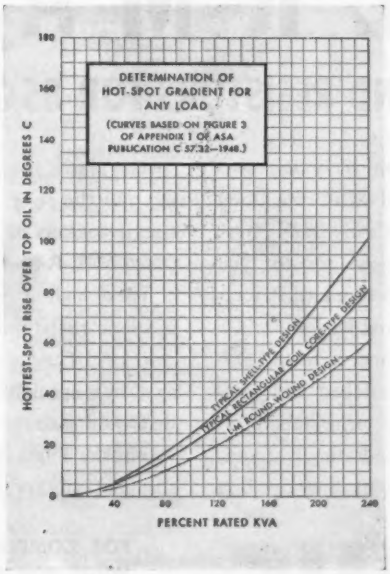
Round-Wound's high short-time overload capacity helps solve the more difficult summer overload problems in residential areas. The efficient cooling system in L-M transformers keeps hot-spot temperatures lower under high short-time overloads, increasing the capacity for overload and reducing the possibility of insulation damage.

For Heavier Residential Loading

Have Higher Overload Capacity



Because L-M transformers expose large, unobstructed areas to cooling oil on the outside of the coil (A), between core and coil (B), and between windings and layers (C), heat is dissipated into oil more rapidly and uniformly during overloads.



The higher the gradient at rated load, the more rapid is the rate of increase in the gradient with overload. Note that L-M's Round-Wound transformer, with a lower temperature differential (gradient) between hot-spot and top oil at rated load, has a greater capacity for overload.

Get Complete Information

Ask your L-M Field Engineer for complete information on L-M's Round-Wound design, and bulletins. Or write Mr. Thompson at Line Material Company, Transformer Division, Zanesville, Ohio.

Transformers

Five Reasons Why More Customers Are Selecting L-M Round-Wound Transformers

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Where We Stand

M. D. HOOVEN
PRESIDENT AIEE

As our 1955–56 Institute President is about to take leave of office, he presents to the membership many thought-provoking ideas for consideration regarding the future of our profession.

THIS HAS BEEN A YEAR of intensive introspection and quiet accomplishment. There are no signs of distress which have arisen among the membership. On the other hand, there is no single outstanding item of glory which can be submitted. There are signs and portents of continued progress.

Prominent among the impressions which the head of an AIEE administration receives is a certain humility which descends upon him because of the large volume and extraordinarily high character of the hard work that is voluntarily turned in by the Board members and the committee, section, and branch officers of the Institute. A tremendous amount of work in all fields is contributed without thought of any reward other than that given by the knowledge of a job well done. When the advancement of the art reposes in the hearts of devoted electrical engineers such as these, the future of the profession and of the community which it serves is well ensured.

No expression of gratitude would be complete without deep thanks also to the Institute's staff who, under the exceptionally competent direction of the Secretary, carry on the day-to-day work of Headquarters. This includes the beyond-duty contribution of individuals who do Institute work for consultants on public relations, public-opinion surveys, financial problems, and management and reorganization projects. There seems to be something about AIEE that generates a will to work in everyone connected with it.

Publications, the greatest single item of routine Institute responsibility, have had a good year. Confronted by rising costs and expanded operations, the net cost to the Institute of all its publications has dropped from $171,000 to under $100,000. The response of the advertisers to the Institute's progressive publication policies and to its expanding coverage has been excellent, in spite of the raises in rates necessitated by increased costs. The betterment of the Institute's publication position has been consistent with the dignity and integrity of a publisher of scientific and educational material.

The directed drift in publication policy toward more articles on electronics reflects the changing complexion of the membership, as indicated by reader surveys which are constantly being carried on. One thousand questionnaires per month are sent to a random sample of the membership. Although it is perhaps unsafe, as yet, to draw general conclusions, present returns indicate that the electrical engineer who was formerly interested mostly in wires, cables, and switchgear is now showing an even greater interest in electronic tubes, semiconductors, and electronic components. Readers interested in meters, instruments, and relays outnumber both. If a mixture of the vegetables which make up the salad of electrical engineering is tasted carefully, it will be found that (to quote from the *Journal* of the Institution of Electrical Engineers in Great Britain), "Electronics (has become) the universal herb for seasoning all present-day electrical recipes."

The Year Book survey, which is more general than those directed toward publication needs, is under way with a tremendously good response. Over 30,000 replies have been so far received; it is assumed that each member present has sent his in. This survey of membership interest will continue to guide policies not only in publication, but also in the conduct of all Institute affairs.

M. D. Hooven is electrical engineer with the Public Service and Gas Company, Newark, N. J.

Full text of an address presented at the AIEE Summer and Pacific General Meeting, San Francisco, Calif., June 25–29, 1956.

TECHNICAL ACTIVITIES

THE TECHNICAL WORK of the Institute has kept pace with the changes in the art. At this year's General Meetings, 845 papers were presented, with the District Meetings having a total of 233 papers. The Special Technical Conferences (14 of which AIEE held and 14 of which AIEE participated in) boasted a total of 953 papers. Adding and rounding out, this represents an average of one paper for every 25 AIEE members! The standards work of the Institute also proceeded in even-better-than-traditional fashion. Three new technical committees have been established. The Instruments and Measurements Committee has been formed into the Instruments and Measurements Division for next year's operation.

The number of sections has been increased to 109. The final draft of the Sections Operations Manual is ready for printing. While final returns are not yet in, it is apparent that this year's Section activities have reached a new peak. The general membership of the Institute, largely as a result of Section activity, has increased to a figure of 49,709 corporate members at the end of the fiscal year, a figure which does not include student or affiliate members. The Board of Examiners had before it 4,233 applications of one sort or another, not including students. Not to make boastful comparisons, but to give a realistic picture of the organized electrical engineering profession, the civils and mechanicals, who with the electricals constitute a majority of engineers, have 39,150 and 40,066 corporate members, respectively. If one adds the 49,709 corporate members in AIEE to the 19,964 corporate members in the Institute of Radio Engineers (IRE) and then reduces the total figure by approximately 5,000 for duplicate memberships, there are now some 65,000 electrical engineers of professional grade in organized electrical engineering. If one includes the affiliate grade in AIEE and the associate grade in IRE, both of which are nonvoting and of semiprofessional status, an additional 20,000 could be added.

Student Branches have increased by seven during the past year, six of which were the new type of branch known as an Affiliate Branch, installed in schools with nonaccredited curricula in electrical engineering. That the branches are doing excellent work is shown by the increase of student members to a figure of 9,458, a 23.4-per-cent increase over last year. These figures are culled mostly from the Annual Report of the Board of Directors, to which your attention is most strongly invited. In this report are found, in proper context and in great detail, full data on the growth and activities of the Institute.

Because of the large number of electrical engineers and their enthusiastic participation in Institute activities, it may sometimes appear that the electrical engineer is, at least, less than fully cognizant of the other facets of the engineering profession. Such is not the case. AIEE, as a matter of policy, offers its full co-operation and participation in all intersociety activities. It is particularly proud of its participation in the work of the Engineers' Council for Professional Development (ECPD). In cooperation with the other similar engineering societies and the Engineering Institute of Canada, AIEE has provided a major source of energy for the Council since it was founded some 23 years ago. ECPD carried responsibility for intraprofessional activities in the engineering field. In its work on accreditation, it keeps high the thresholds of admittance to the profession. It provides engineering colleges with the proper stimuli and criteria for the continued development of the profession.

In activities of the Engineers Joint Council (EJC), an organization consisting of most of the members of ECPD, plus some 10 engineering societies, who are associate or affiliate members, AIEE also takes part in its work and deliberations. As one instance among many to which AIEE has presented its full support, the Engineering Manpower Commission, a committee of EJC, is able to report (because of a large extent to its specific work in that field) that the downward trend of engineering graduates has been reversed. The U. S. Office of Education, in a booklet published May 1956, reports "From 1954 to 1955, engineering enrollment increased for the fourth consecutive year, and by a substantial 13.5 per cent."

The year has been one of hope and encouragement—with continued growth in spite of the first dues increase in 50 years, a financial position far stronger than expected, continued expansion, and greater coverage in the many and varied fields of electrical engineering. Beyond the area of accomplishment, however, there have appeared in this year of introspection other areas where progress in consolidation of Institute opinion has been distressingly slow. Next year's administrative year will continue to be one of hard work and high interest.

There has not, however, been any area of conflict in fundamentals; differences of opinion appear only in the means of accomplishing goals which are almost universally accepted.

ORGANIZATION

AIEE has traditionally maintained its primary interest in technology. It is now, and has always been, an organization extremely proud of its democratic traditions. Does its present organization serve both ideals well? Are its officers and Board members as well distributed functionally as they admittedly are geographically? There are differences of opinion here. All thoughtful persons wish the representation to be fair; many believe the present distribution of officers and Board members is correct; many others believe more emphasis should be placed on representation from the various functional areas in which the technical work of the Institute divides itself. The Chairman of the Communications Division has, for instance, pointed out in a recent letter to his technical committee chairmen that no President has ever been elected from the electronics groupings. An immense amount of soul-searching on the part of coming administrations is required for the solution of this problem.

GENERAL UNITY

EVERY AIEE MEMBER apparently favors unity of the engineering profession. Over many years, questionnaires, opinion surveys, and innumerable committee and section meetings have seemed to indicate that electrical engineers

favored an individual-membership over-all engineering society divided into technical groups and a professional group. EJC, in the original exploration and formation of which AIEE members played an important part, turned out to be rather more of a federation than a unification, a culmination required by the usual necessities of compromise among independent bodies. Since the National Society of Professional Engineers (NSPE) did not accept the invitation to join EJC, EJC was left without a specific division to deal with purely professional subjects, then forming committees of its own which thus have some duplication with NSPE. Some AIEE people are satisfied with this arrangement; some are not. A considerable group think that a means should be found for AIEE to support NSPE in certain approved activities. Unity organization schemes are numerous. Past-President J. F. Fairman, in his speech of acceptance of Honorary Membership, said in January:

> "We exhaust ourselves in fruitless arguments about how to organize to do what needs doing when we should be concentrating our efforts on doing what needs doing. If we could only learn to co-operate in working to attain the important objectives of the profession, I am convinced we would more quickly devise the organization tools needed for more effective accomplishment."

There will continue to be, however, great concern within the Institute as to how unity of the profession can most effectively be achieved.

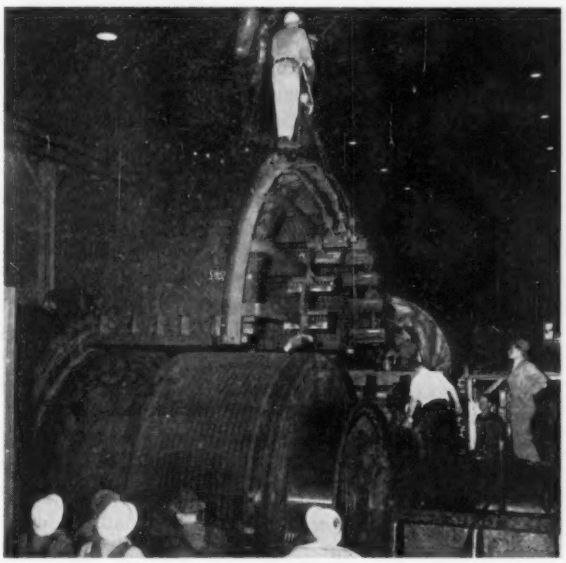
UNITY IN ELECTRICAL ENGINEERING

No engineer in AIEE or, it may safely be said, in IRE would countenance an open split in the profession of electrical engineering. And yet there is danger of just this. From an 1884 organization of wire-telegraph engineers, AIEE grew with the development of the art into its present wide coverage. From a 1914 organization of wireless-telegraph engineers, IRE grew into its present wide coverage. No longer is there a great common membership, less than 15 per cent belonging to both organizations. The impact of electronics on both institutes has resulted in an explosive increase of membership in each since World War II. IRE has traditionally stayed almost entirely within the straight technical field; it, like NSPE, did not accept the invitation to join EJC. The two institutes work amicably together in the student branch field, most student branches being joint, and in the field of technical development. Many sections hold joint meetings. And yet there cannot help but be keen competition for new members. Does this help the development of the electrical engineering profession? Or does it hinder it? Should the two societies co-operate? Or compete? Or unite? These are important questions that must be asked in the coming years.

These, although outstanding, are but a few of the questions that will plague the incoming administration for answers. There are great days of thoughtfulness to come. Each question must be resolved by AIEE in the spirit of its Constitution, which says that "its object shall be the advancement of the theory and practice of Electrical Engineering and of the allied Arts and Sciences and the maintenance of a high professional standing among its members." Each Institute member must deliver to the group in which he is working not only his technical competence, but also his engineering and social imagination. As during the past year I needed and received just that from the Institute membership, so will the incoming president require all the help he can receive from each of you. I can promise it to him.

I have enjoyed being your president; I thank you for having accorded me a delightful year of responsibility. I pass that responsibility on with perhaps a tinge of regret that I have not accomplished all that I had hoped to, but with the assurance that next year's administration, with its obviously high capabilities, will lead the art, the profession, and the Institute into fields of ever greater accomplishment. Godspeed!

Engineers Speed Maintenance Job



U. S. Steel Corporation engineers recently teamed with General Electric Company specialists to save more than 5 days down time on a normal 10-day job at the Geneva Works of the Columbia-Geneva Steel Division of U. S. Steel. As a part of the productive maintenance program, engineers were able to set up and replace one armature and one-half set of the field coils on a 7,000-hp double-armature motor in record-breaking time by prefabrication and preassembly of the major parts at General Electric's Schenectady (N. Y.) plant. The parts were assembled in a special fixture designed by engineers for the job. The new armature, shown above, is being slowly lowered into place in the motor.

Limited Technical Manpower Resources for the Armed Forces

A. W. DAVISON

Speaking for all 11 member organizations of the Engineers Joint Council (EJC), the Chairman of the Engineering Manpower Commission of EJC discusses the engineering manpower shortage, especially as it affects the Armed Forces.

SINCE 1951, the major goals of the Engineering Manpower Commission of the Engineers Joint Council (EJC), acting on behalf of the principal engineering organizations of the country, have been three: (1) to indicate to our country the growing importance of engineering to our economic development and national security, (2) to promote the most effective utilization of engineers, and (3) to insure a continuing flow of qualified students into our engineering schools. The basic motive of such activity is, of course, to fulfill the obligation of a professional group to anticipate and explain the probable effects of new technological developments on the structure and functions of our society. One of the most notable developments in technology, which had taken place gradually until 1940 and thereafter with an almost revolutionary impact, has been the tremendous growth in technical activity and the consequent growing importance of engineers, scientists, and technicians of these professions. The fact of atomic development, potent as it is, is only one of several recent reasons for the accelerated interest in technologists. As a matter of fact, the impact of nuclear needs is apparently only beginning.

The genesis of your interest in the problem of technical manpower is your great responsibility for the construction and maintenance of an atmosphere in our country in which the great promise of atomic application can be achieved rapidly. In a unique way, engineers can appreciate the stakes involved. It must be recognized that the technologists for nuclear requirements, now and in the future, must come from the same intelligent and highly educated group as will be expected to fill the over-all technological needs of our country. It is, therefore, pertinent to discuss the present situation of availability and need, as well as the probability for the immediate future.

NEED AND AVAILABILITY OF ENGINEERS

WHENEVER the subject of need for engineers is discussed, it is essential to provide a framework of over-all quantities and recent trends. There are employed in the United States now about 650,000 persons who may be classified as engineers. This is just about 100 per cent more than were employed in engineering in 1940. Incidentally, it is pertinent to note that, since 1946, there have been absorbed into our economy over 260,000 bachelor graduates of our engineering curricula. About 415,000 engineers currently are employed by private industry. Of these, about 130,000 are employed in research and development activities which have, incidentally, increased 1,000 per cent since 1941. Approximately 120,000 engineers are involved in some kind of Government activity—Federal, state, local, or military. It may be pertinent to note that about 13,000 additions to the profession are needed each year, just to replace those who leave for reasons of retirement and what might be called natural causes.

Each year, since 1951, the Engineers Joint Council has made a study of demand for engineering curriculum graduates in industry, education, and Government. These samplings have consistently indicated that the over-all need for engineering graduates was substantially greater than the size of the graduating classes. This was the situation in 1951, when about 38,000 degrees were awarded; in 1952, with 27,000 graduates; in 1953, with 22,000 graduates; in 1954, with 21,000 graduates; and, in 1955, with 22,000 graduates. The results of this year's survey have not, as yet, been fully appraised, but it is possible to provide some indicative values. Replies have been received from about 415 industrial and governmental organizations which employ about 135,000 engineers. The firm recruiting goals of these organizations, if filled, would require about half of the entire 1955–56 graduating class in engineering.

GOVERNMENT AND UNIVERSITIES

WITHIN THESE CONSIDERATIONS, it is not difficult to understand what might be called some peripheral effects of this 6-year period of manpower deficiency. Government organizations and institutions of higher learning are for different reasons—unlike industrial organizations—unable to react promptly to the realities of the market place for technical manpower. It is to be expected, therefore, that the discernible results of continuing stress would manifest themselves sooner in these organizations than elsewhere. It is very significant, yes ominous, that for several years now many of the most important Government employers of technical personnel and many institutions of engineering education have shown annual net losses in their struggle to maintain technical staffs reasonably adequate to their missions.

For example, the Corps of Engineers of the Department

Essentially full text of an address presented before the Subcommittee on Research and Development of Joint Congressional Committee on Atomic Energy, April 25, 1956.

A. W. Davison is chairman of the Engineering Manpower Commission of Engineers Joint Council.

of the Army, the largest employer of engineers in a civilian capacity in the Federal Government, has, for several years, been unable to recruit a sufficient number of engineering graduates to meet its requirements. Meanwhile, their losses of engineers to other employments are reported to be constantly increasing to an extent constituting cause for concern. This situation can be duplicated in many Government departments and agencies, charged with vital national security programs. As far as engineering education is concerned, Dean Eric Walker of Pennsylvania State University, State College, Pa., recently stated: "We would have to expand in all directions—facilities and manpower—if we were going to take in any more students, and at the bottom of all this is money. Costs are going up very rapidly just because the cost of living, in general, is going up. Engineers are getting more expensive; engineering equipment is getting more expensive; buildings are getting more expensive. Unless we have very large appropriations for expansion, I fear we will not be able to take in any larger freshman classes."

RATIO OF ENGINEERS INCREASED

MANY OTHER SPECIFIC EXAMPLES could be cited, but there seems little point in giving further emphasis to the obvious. All of these facts, however, suggest the conclusion that, presuming the continuation of the current rate of technological growth and, also, the continuation of traditional patterns of utilization of technical personnel, there probably is no merely numerical solution in the years immediately ahead to the problems raised by the dearth of competent technologists. This conclusion, which may seem startling, is, as a matter of fact, also suggested by the consideration of an historical fact in relation to some basic knowledge about our human resources potential. The historical fact is that ever since technology began fundamentally to affect the fabric of our economic system, the ratio of persons with high technical training to all other productively employed persons has been increasing. It is common knowledge now that while, for example, in 1900 this ratio was about one such person to 250 workers, it is now about one engineer or scientist to every 60 workers. In certain industrial activities, the ratio is even greater. Every indicative measure that can be applied suggests that this development will try to continue, quite possibly at an accelerated rate. But it must inevitably level off for the very simple reason that the limits of our people to profit from any kind of professional training will be reached —and this condition of equilibrium may be closer than is realized. Indeed, a startling fact is that about 40 per cent of our college qualified youngsters do not go to college. The really startling fact is that about 60 per cent do go. Now it must be added, of course, that in a dynamic economy such as ours, this trend of technical employment will undoubtedly be subject to momentary checks, but the long trend line is there—clear for all to read. It is interesting to note that in Great Britain, Canada, West Germany, and other countries in which technology has been recognized as a powerful economic factor, there is great concern at the very highest levels about the availability of technical personnel. Everyone knows of the pressures the Russians are applying to achieve a status in this regard similar to our own.

DEVELOPMENT OF ENGINEERS

THE DEVELOPMENT of engineers and scientists is mostly an educational process. It is most appropriate, therefore, that much interest be given to this educational process. Inasmuch as many persons have discussed educational needs before, there is no intention here of going over already well-explored ground, except to emphasize the present and long-range need for the availability of more and better science and mathematics teaching at all levels of our educational system. Steps must also be taken, of course, to insure that our institutions of higher education are able to preserve high standards during a period of steadily growing enrollments.

However, the same root from which education draws much of its great value and strength is, in terms of its relation to the present problem, also a source of great weakness. It takes a long time to educate an engineer or scientist or for that matter, any competent professional person. What can be called educational lead time may be the single most important fact for immediate consideration.

If all could agree today on what needs to be done educationally not only in engineering and science, but also in the other fields important to our national future, and if procedures could be started to accomplish the initiation of programs tomorrow, it would still take at least 5 years and more, probably 8 years, to achieve any important results. Only this year, for example, the benefits will begin from Engineers Joint Council's efforts started in 1951 to bring engineering enrollments back into more rational balance—a balance from which they had fallen. It is unfortunately clear, however, that as atomic energy, and indeed technology, more broadly speaking, is important to our national security, including the burgeoning aspects of economic competition, the next 5 years will be the crucial ones. In short, plans must be made for winning the contest with the men already on the field and in the dugout—the students already in our engineering and scientific curricula.

UTILIZATION OF ENGINEERS

IT IS MOST IMPORTANT, therefore, that consideration should thus be given to the utilization of engineering and scientific personnel. Actually, the problem is more than just utilization because it involves not only what engineers do, but also the employment atmosphere, rewards, etc. In general, 5 years ago almost all areas of engineering employment were weak in this respect, at least to some extent. There was, therefore, reason for the great emphasis on utilization contained in the approach to this problem by the EJC.

It is, of course, impossible to discuss here other than overall trends. In industry considerable progress has been made and continued progress is expected. This results not only from the economics involved, but also from the growing realization of the factors, as discussed. Never before has there been such a search for the know-how essential to the

development and most profitable utilization of technical personnel. The record clearly indicates that industry learns quickly and adjusts quickly to inevitabilities and changing times. Much remains to be learned and accomplished, but the climate of attitudes necessary to improvement is forming rapidly. There is always the safety valve that the dissatisfied technologist can change employers—and many do.

GOVERNMENT EMPLOYEES

In general, the Federal Government, operating within a very different set of organizational requirements, has been all too slow in adjusting attitudes and policies to the realities of the technical manpower situation. It has already been mentioned that many important Government employers of engineering personnel are losing many of their most competent people to private industry. There is little doubt that much of this results from the inability of Federal agencies to compete with other employers of engineers in paying for outstanding talent. It is felt, too, that the abolition of the professional service in the Classification Act of 1949 has contributed to the situation. Others would know more about the mechanics necessary, but it certainly appears that action is required which would provide authority in the Federal Government to adjust salaries for engineers and scientists in the employ of the Federal Government, so as to keep them in reasonable alignment with those paid by other employers of engineering and scientific personnel. At the same time, consideration should be given to the establishment of an appropriate professional service under the Civil Service Classification Act for positions which are determined by the Civil Service Commission to truly require the knowledge, experience, and education of the learned professions. This would add to the prestige and recognition not only of engineers and scientists in the Federal Government, but also all engineers and scientists, and would be a significant element in improving their employment status.

MILITARY SERVICES

At this point, it should be pointed out that the military services have advanced considerably in their understanding of the problem of scientific manpower and in their willingness to deal constructively with it. This is demonstrated by the progress which has been made in the reorganization of the military reserve in accordance with the provisions of the Reserve Forces Act of 1955. It unquestionably is largely the result of the capable leadership provided by the Assistant Secretary of Defense for Manpower and Personnel, Carter Burgess, and by the officials with appropriate responsibilities in the Office of Defense Mobilization and the Selective Service System. However, there are additional improvements which need to be made but which will require, it seems, additional Congressional legislation.

The largest single under-utilized group of young experienced engineers and scientists cannot voluntarily change their employment status inasmuch as they are all Privates—perhaps a few Corporals—in the U. S. Army. In number, they are not less than 5,000 and probably closer to 9,000. These are men who were inducted during the past 2 years and who currently are serving a 2-year tour of active duty. About 5,000 of these are assigned to the Army Scientific and Professional Personnel Program. These men are, for the most part, not what might be called green youngsters who are just out of school. Many are men with advanced degrees and certainly a majority have had substantial industrial experience. They are in the Army as a result of what is called the Universal Military Service cleanup, which resulted, in 1953 and 1954 and for a while in 1955, in the more or less arbitrary induction of men who had previously been deferred for reasons of occupation. These, in short, are the very men whose experience would make them extremely valuable in civilian tasks at this time. This situation is not cited to criticize the Selective Service system. It acted in accord with what it considered to be a Congressional Mandate contained in the Universal Military Training and Service Act of 1951—a mandate that was discussed during the first session of this Congress. This is an excellent example, however, of the effects that the application of governmental authority can have when policy is determined by considerations having little to do with the most crucial facts.

Quite frankly, the EJC and the Army have an honest disagreement about the use to which these men are being put. The result of post-service interviews with many of them is that, although a few are well used, the majority are wasting a large percentage of their own and the Army's time. The Army says it is not so—it is a dilemma on the resolution of which little real progress has been made. Less it be misunderstood let it be said that EJC has always felt that the Armed Forces should have first priority for all the engineers needed as such in uniform. EJC has suggested, that to no avail, the use of the early release authority given by Congress to the Department of Defense. It may be equitable to insist on the continuation of this situation, but it constitutes senseless squandering of the limited technical manpower resources and is clearly out of phase with the true needs of the times. It should, therefore, no longer be tolerated.

Of the approximately 27,000 young men who received bachelors degrees in engineering this year, about 6,600 will also receive Reserve Officers Training Corps (ROTC) commissions, to be followed by active duty orders for the Army, Navy, or Air Force. It is not realized generally that, save for exceptional cases, no attempt is made to assign young officers serving an obligatory 2-year tour to duties for which they have been specifically prepared by their engineering education. The reason offered for this is that the purpose of the required 2-year tour is to give military training to the individual concerned rather than to receive technical service. Whereas engineers can understand and even sympathize with this attitude, they seriously question its wisdom in these crucial years.

As one example of what happens, consider the man who held an important fellowship in metallurgy at Columbia University last year and received a Masters Degree in Metallurgy last June—according to his professors a very promising young metallurgist—and was also an Army ROTC student. He recently was called to active duty to serve his obligatory 2-year tour. Initially, he was assigned

as a motor pool officer. This means that he controlled the issuance and accounting of various military vehicles. He was recently transferred to a school where he will apparently learn to be an ammunition officer. Meanwhile, he will make no contribution to the advancement of the field of metallurgy for at least 2 years. This situation exists at a time when most of the barriers to significant breakthroughs in atomic energy application, and jet and rocket propulsion are problems in metallurgy. This condition exists when the Army itself requires metallurgists for its own research and development programs.

SCIENTIFIC CORPS

IT SEEMS LIKELY that the military services will need to develop a separate scientific corps, as is done with medical personnel, and to establish a career service. This service should include only persons who by the nature of their scientific and engineering work need to be in uniform.

As a matter of fact there was reason, a year or so ago, to believe that the Department of Defense was moving in this very direction. In an excellent summary of this situation presented to the 48th Annual Meeting of the Chamber of Commerce of the United States, Carter Burgess said:

> "Through the ROTC, we hope to provide an ever-widening range of service opportunities. At the present time, we are studying the feasibility of a program to encourage development of specialists for the military and defense industry. By specialists, we mean engineers and scientists along with linguists, logisticians, financial management experts, and others in fields closely related to our defense needs.
>
> "My own feeling is that such an expanded ROTC program in our colleges has become of prime importance. We all know of our shortages in technically trained personnel, both inside and outside the military services.
>
> "A redefined and greatly varied ROTC program would work first to the advantage of the military, but would also have to be considered as a first-class training ground for defense industry as well.
>
> "The Department of Defense intends to continue its careful reappraisal of the ROTC with the intention of integrating it more closely with the over-all defense program. In addition to other considerations, we will need a large production of ROTC graduates to fill requirements for the 6-month active training and ready reserve program."

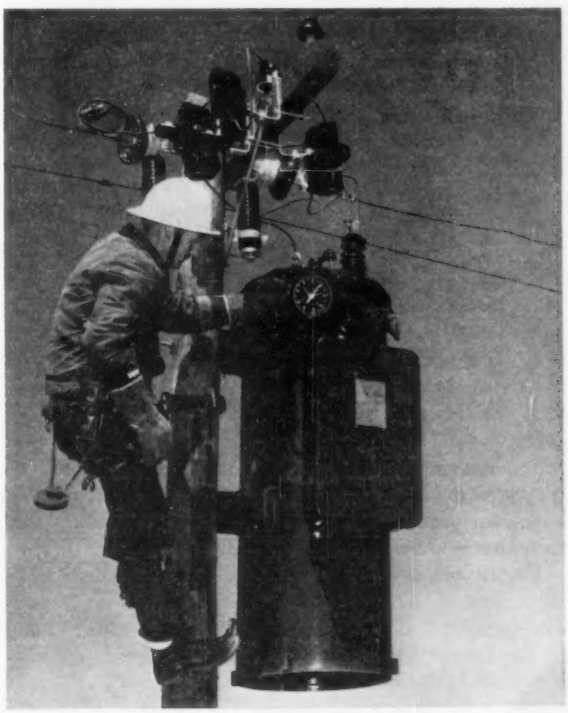
Since nothing further has been heard regarding this development plan, it can only be assumed that for some reason this excellent conception of the problem and realistic approach to it has been discarded. However, the need for it has actually increased.

ENGINEERING PROFESSION

MANY GROUPS in our society have contributed toward the productivity and the material welfare of this country and there is no intention here of minimizing their contributions; however, it is true that the engineering profession is the only major group whose primary reason for existence is to increase productivity and, thereby, to continue the development of our strength and abundance. There would be no engineering profession and no need for engineering schools if all new machines, structures, circuits and processes, all new plants and systems, all new highways, chemical works, steel mills, airplanes, instruments, etc., were merely replicas of those already in existence and were acceptable at the same cost and performance. However, it is clear that the basic *sine qua non* of our economic and national security programs is dissatisfaction and a continuing intense drive for improvement. The Federal Government can make an important contribution to the pace of our technological process by insuring that the necessary application of government authority does not seriously impede the development and utilization of the very small fraction of our population who are crucial to our continued technical progress.

It is the nature of our system of government that, ultimately, Government policy has to have the understanding and approval of our people. The most perfect mirror of public opinion in this country still is the Congress of the United States. Using this as the basis of judgment, it is safe to say that our problems are understood well enough so all can move forward to accomplish what needs to be done.

Adjustable Limit Switch



General Electric Company's new *ML32* single-phase step-voltage regulator has a limit switch, adjustable without interrupting service. When full-range regulation is not needed, narrower settings allow the regulator to carry a current "load bonus" up to 160 per cent of its rating.

The Present and Future of Telephone Transmission

H. R. HUNTLEY
FELLOW AIEE

A review is presented of the progress and problems in the field of telephone transmission. The job of improving transmission while keeping costs low is divided into three main elements: instrumentalities, engineering, and maintenance.

THE PRINCIPAL BUSINESS of the telephone industry is to provide circuits and switching arrangements so that people who are physically separated can talk to each other. It also is in the business of transmitting other forms of information (teletypewriter, data, radio programs, television, etc.) from one place to another. The things which affect talking and transmitting other information are called "transmission."

Transmission is such an important factor in the telephone business that its basic objectives must be the same as the basic objectives of the business itself, which are the same as those of any other economic enterprise; that is:

1. It must create customers and keep them happy.
2. It must take in enough money to pay its employees adequately, to satisfy its creditors, and to make enough profit so that many people will want to share in its ownership.

From these basic objectives and even from a rudimentary understanding of people and their motivation, it is possible to derive more concrete objectives applying to transmission, namely

1. Transmission must get more pleasing and attractive to customers continuously.
2. It must encompass an ever-widening field as customers' views and needs change.
3. Its cost must be kept as low as practicable.

OVER-ALL PROGRESS

AT THE START, it may be well to summarize the progress which has been made in telephone transmission and which seems likely in the reasonably near future.

Under present conditions, the best over-all single measure in ease of talking is the ratio between the acoustic pressure (weighted in accordance with loudness) of the sounds in the listener's ear and the acoustic pressure (similarly weighted) of the sounds at the talker's lips.

This ratio of acoustic pressure on typical calls has improved greatly in the past and it can reasonably be expected to improve further in the future. Table I compares this ratio today with conditions 25 years ago and makes a prediction of what is expected 5 or 10 years hence.

The figures for typical calls 5 to 10 years hence are roughly equivalent to talking a few feet apart in open air, such as across a desk.

WHAT PEOPLE WANT

IF THE TELEPHONE BUSINESS is to create customers and keep them happy, it must know not only how people like the transmission they are getting, but also what they would like if there were no technical or economic problems to be overcome.

A wide variety of things are done to answer these questions, including such things as organized programs of asking customers what they think; judgment tests by telephone people, from a wide variety of jobs, serving as guinea pigs, etc. The results of all of these various methods are reasonably consistent among themselves and with field experience and can be summarized briefly as follows:

1. People, especially those who make a large number and variety of calls, are quite critical and will call transmission only "fair" or even "poor" on calls on which it is perfectly possible to talk without repeating at all or, at most, only occasionally.
2. Although most people are satisfied with the transmission they get on most calls, there are still many calls which they do not like because the received sounds are not loud enough or because noise interferes with the conversations.
3. With the acoustic pressure ratios shown on Table I, and assuming that not too many calls have significantly poorer ratios and are not adversely affected by noise, there should be very few calls 5 or 10 years hence which people would consider poor.

This is only part of the story, because beyond mere improvement in acoustic pressure ratio, people will want transmission to be still more pleasing and convenient in other respects.

Already many of them want to talk over the telephone without holding anything in their hands—and this hands-free method probably will spread, just as clutchless gear shifting is spreading in the automobile field. Perhaps, also, some years hence people will want to see as well as to hear. And, in addition to talking (and possibly seeing), there will undoubtedly be a whole host of new requirements for data

Revised text of paper 56-780, "Where We Are and Where We Are Going in Telephone Transmission," recommended by the AIEE Committee on Wire Communications Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer and Pacific General Meeting, San Francisco, Calif., June 25–29, 1956.

H. R. Huntley is with the American Telephone and Telegraph Company, New York, N. Y.

transmission to computing machines, television of all kinds—fast, slow, color, and maybe even "3D"—and nobody knows what else.

But whatever comes, it is the job of the telephone industry to provide the means of transmitting the necessary information.

THE ELEMENTS OF THE PROBLEM

THERE ARE three main parts to the job of improving transmission and keeping costs low, i.e., instrumentalities, engineering, and maintenance. They are like the legs of a tripod, the soundness of the whole transmission structure depending upon how well each carries its load, and upon how well each is co-ordinated with the others.

In order to fashion an over-all transmission structure which will do the best practicable job at the lowest practicable cost, a wide variety of instrumentalities must be available, and they must be capable of high grade performance and be not too expensive.

But mere availability of high quality and low cost instrumentalities is not enough. They are only the bricks and mortar out of which a structure can be fashioned. The structure itself must be designed by engineers, and what they do with the instrumentalities they have and how well they prepare for instrumentalities to come are as importat as the instrumentalities themselves. Regardless of the quality of the instrumentalities and the soundness of the engineering, the desired results will not be obtained unless the whole complex is so maintained that actual performance is very close to its design capabilities hour after hour, day after day, year after year.

These three parts of the problem will be discussed in turn.

Loops and Trunks. Before discussing these parts of the job in detail it may be well to delineate the two main categories of the plant from the transmission standpoint because the problems and methods are quite different. These two main categories are loops and trunks as shown in Fig. 1.

All telephone connections involve two loops or circuits (usually pairs of wires) connecting customers' telephones to central offices (switching centers), with central offices connected together by trunks.

A large number of the calls are between customers served by the same central office or by different central offices in the same exchange area (usually a single community or a closely related group of communities) which may be connected by direct trunks. On many calls there are two or more trunks in tandem between the central offices, and in a few of the more complex long-haul connections of the future there may be as many as 10 trunks in tandem between the central offices.

In addition to the fact that there are often physical and electrical differences between loops and trunks, there is another difference which has important economic and service reactions. A loop is a circuit which is set aside for the exclusive use of a single customer or of a small group of customers who constitute the parties on a party line. On the other hand, a trunk is a circuit which is used by many different pairs of customers in succession.

Differences in diversity result in a very large difference in the numbers of circuits in the two categories. Thus, there are about 25 million loops serving some 50 million telephones but less than two million trunks.

Table I. Progress in Making It Easier to Talk

	Approximate Ratio of Acoustic Pressure* Talker's Lips to Listener's Ear	
	Typical Long Distance Call †	Typical Local Call †
25 years ago	45 to 1	30 to 1
Now	20 to 1	13 to 1
5 to 10 years hence	6 to 1	4 to 1

*Weighted for bandwidth, sidetone, etc.

† Individual calls may differ considerably from "typical" values.

(Present range is about ±3 to 1 from figures. Range was greater in past; will be less in future.)

INSTRUMENTALITIES

Telephones and Loops. The customer's telephone and loop form a unit, and the transmission which this combination provides is a function of both of its parts. The telephone is one of the most important in the whole gamut of transmission instrumentalities.

Telephones come in a wide variety of sizes, shapes, and colors. But the only reason why any customer has one at all is to talk over it. And improvements in telephones are a very important factor in improvements in transmission and in keeping costs low.

Utilization of improvements in efficiency of telephones can obviously be directed toward either or both of two objectives: to improve transmission and to keep costs down.

For some years now, and for the foreseeable future, the economics of the over-all situation are such that these improvements have been and will be devoted as far as practicable to control of costs. Primary responsibility for transmission improvements will be allocated to trunks, because the job can be done there more effectively and at less cost, as discussed later.

There are two ways in which set improvements can be used to help limit costs:

1. Finer loop gauges can be used.
2. Transmission limitations on number and locations of switching centers can be greatly reduced, thus permitting use of the most economical arrangements.

However, transmission improvements alone do not necessarily permit finer gauges or longer loops because it is also

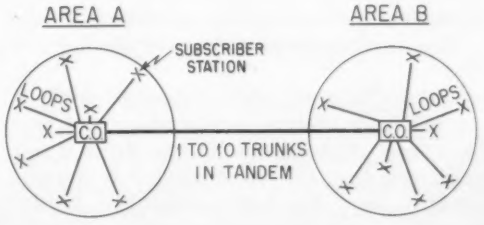


Fig. 1. Loops and trunks.

necessary to transmit signals from the customers' telephones to tell the switching gear what connections to set up and when to take them down, and from the switching gear to the telephones to tell the customers that somebody wants to talk with them.

All through the history of loop design either signaling or talking has controlled the use of gauges for loops of different lengths. At the moment and in spite of the fact that signaling limitations have been greatly eased, loop plant is controlled by signaling, although not by a large factor.

The next big step, therefore, must encompass both transmission and signaling improvements—and they are both being worked on intensively.

Helpful as they may be, however, improved signaling and increased transmission efficiency will not completely overcome the basic economic problem of lack of diversity in the use of the loop plant. Something even more drastic is needed. There are two obvious ways to go about this problem, and starts have been made along both paths.

One is the carrier method which, at the moment, is most attractive in the rural plant.

The other method is line concentration, which extends the trunking principle of diversity to some point between the main switching installations and the individual customers. Line concentration has had only limited application so far, but it is under active study both here and abroad.

At the present time, the equipment involved is still quite expensive. But since the cost of equipment is almost entirely the cost of fabrication of components and assembling them into working circuits, the cost can—and will—be reduced as quantities increase, manufacturing techniques improve, and designs get better.

Trunks. As indicated before, trunks must carry the major part of the burden of further improvements in transmission, as they have in the past. They are in a better position to carry this burden than loops because there are so few of them relative to the number of loops, and they are usually longer.

Although long lengths increase technical problems and require almost fantastic precision in components, design, engineering, and maintenance, they do facilitate the use of electronic instrumentalities, upon which the promise of better transmission at low cost rests.

The two most widely used forms of electronic gear are voice-frequency repeaters (two-way audio amplifiers with associated circuitry), and carrier type (equipment which permits a pair of wires or coaxials to carry several or thousands of circuits). Radio is also a form of electronic gear, but in the telephone industry its principal application is as an alternative to wires and cables as a base facility for carrier. This subject is discussed more extensively in the next section.

Here it may be worth while to examine briefly an important difference between circuits which have electronic gear and those which do not. Once a circuit is equipped with electronic gear, the loss at which it is operated does not affect its cost. The loss at which it is operated depends solely on how the electronic gear is adjusted. The manner in which the electronic gear is adjusted depends entirely on technical factors and not at all on economic factors.

This is not true for a circuit without electronic gear; the longer they are, the heavier the conductors must be, so the costs per circuit mile go up with length.

Whereas both carrier and repeaters have the advantage of divorcing cost and loss, carrier is particularly advantageous for the longer circuits, because it has a high velocity of propagation and is basically 4-wire. In 4-wire operation, transmission in one direction travels on a different pair of wires or radio beam or in a different frequency region from that in the other direction, which greatly simplifies problems of echo, crosstalk, and singing. It would be difficult to overstate the transmission advantages of carrier for the longer circuits. For a given loss, a carrier circuit can be five or six times as long as the best voice-frequency cable circuit and 20 times as long as the more common type of cable circuit.

It is not too much to say that carrier is the most important single factor in providing good transmission on long distance connections, and in permitting the telephone industry to proceed with its rather complex plans for industry-wide dial operation with full assurance that the customers can talk, and talk well, over the connections set up by the machines. Thus, for trunks of lengths where carrier is economical, the burden of providing low transmission losses is a very slight one. And, in fact, if it were economically practicable to use carrier in all trunks the job of providing optimum transmission would be greatly eased.

However, carrier has the characteristic that while it reduces the cost per circuit of the base facilities (line plus carrier repeaters or radio beams), it does so only by using relatively complex electronic gear at the ends. The contribution to cost per circuit mile of the terminal equipment is inversely proportional to length, whereas the contribution of the base facilities is independent of length. This situation leads to two rather distinct phases of carrier development.

One phase results in what might be called "long haul" systems, which are primarily for use where the terminals are so far apart that their contribution to cost per circuit mile is small as compared to the contribution of the base facilities. These systems are characterized by very efficient use of base facilities, made possible by relatively complex terminal equipment and elaborate regulating systems. Probably the best examples of this line of development are the coaxial systems which are extensively used here and abroad.

The other phase of development is directed toward the "short haul" systems. Here the emphasis is on producing the cheapest and most flexible terminal equipment practicable, so that the terminals can be close together without contributing extensively to cost per mile. Efficient use of base facilities is sacrificed to the extent necessary (but no more than this extent) to accomplish this aim.

The service and economic advantages of being able to use carrier in shorter lengths are pointed out in Fig. 2. As shown, over 90 per cent of the trunks in the Bell System are less than 25 miles long and over 80 per cent are less than 15 miles long.

Even with the modern short-haul carrier systems which

are on the market, it is difficult to prove in carrier at distances below about 15 miles (at least in cable areas). This is not necessarily a long-term condition because there is no reason to believe that the ingenuity of the industry in developing new types of carrier and in producing carrier cheaper has been exhausted. In fact, it is reasonable to expect that transistors and other new forms of components, together with increasing knowledge will, if anything, accelerate the historic trend in favor of carrier vis-a-vis voice-frequency cables and wires.

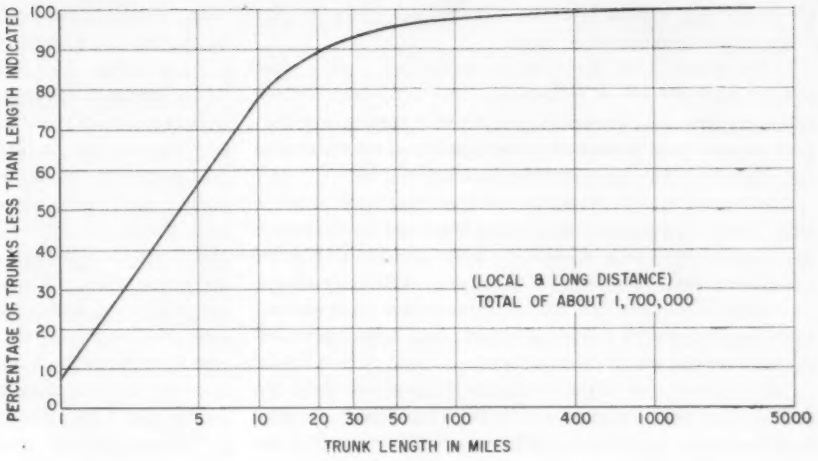


Fig. 2. Length distribution of Bell System trunks.

At present, it is necessary to use voice-frequency circuits for 80 per cent of the trunks, and the thing which has had a profound effect in this field is the modern version of the voice-frequency repeater, the negative-impedance design.

Negative-impedance repeaters permit adding amplification in the voice-frequency range at such low cost that fine gauge wire (usually 24 with some 22 gauge) can be used for practically all trunks which are too short for carrier.

While reduction in conductor size has not offset the increase in cable costs over the past 25 years—or even the last eight years—it has at least softened the blow so that trunk costs even in the shorter lengths have not gone up as rapidly as cable costs.

The increasing penetration by electronic gear into shorter and shorter length ranges is causing repeaters and carrier channels to be produced in quantities which would have been considered astronomical only a few years ago. For example, before World War II, repeaters were added in a few tens of thousands per year; now they are going in at a rate of over 100,000 per year. Before World War II, carrier channels went in at a few thousand per year; now they are going in at 30,000 to 50,000 per year. It is primarily upon this electronic gear that the promise of better, more convenient, and more pleasing transmission rests.

Radio. Of the 33 million miles of telephone carrier circuits in the Bell System, almost 23 per cent are on radio relay. Of the 69,000 television channel miles, almost 70 per cent are furnished by radio relay.

The current heavy-duty radio relay system is the *TD-2*, which operates in the 4,000-mc band. In approximately five years *TD-2* has grown to the point where it has about 1.6 times as many route miles as coaxial cable. These routes carry almost 70 per cent as many telephone circuit miles as coaxial cable and almost 2.3 times as many channel miles for television service. Usually, *L1* carrier channelizing is used on *TD-2* for telephone service.

Work is going ahead rapidly on an even heavier duty radio relay system which will operate in the 6,000-mc band and with which *L3* carrier equipment will probably be used for telephone service. Like the *TD-2* it will be capable of high-grade color as well as monochrome television transmission.

In the short-haul field, radio is used for only a comparatively small percentage of the total circuit mileage. This is partly because suitable systems have only recently become available and partly because as a base facility it must compete with existing base facilities (the very large existing networks of cable and open-wire lines) which still have some room for carrier. However, it seems very likely that the use of short-haul microwave systems will increase quite rapidly to take care of growth in areas which are largely supplied by open-wire lines and to secure improved service reliability by diversifying routes and types of facilities.

In addition to the use of radio as base facilities for carrier, the telephone industry provides an extensive mobile telephone service. The more than 15,000 cars, boats, and trains equipped with this type of service can make calls anywhere over the regular telephone network.

OTHER FORMS OF TRANSMISSION

EVEN THOUGH transmission on ordinary telephone calls (local and long distance) is by far the largest quantitative factor in the transmission job, there are many other parts to the over-all problem. Some of these other parts involve speech transmission, but others involve significantly different forms of transmission.

Forms of transmission other than speech include such things as teletypewriter and much faster forms of pulse transmission (as for computers or other data processing and utilization schemes), transmission of photographs, and television. It is obviously impracticable in the space available to do more than mention one or two of these forms of transmission.

Television. Most engineers are aware that the telephone industry furnishes an extensive intercity television transmission network and most of them are probably aware that color television transmissions occur over at least some parts of it. But it may be of interest to know that a very large proportion of this network has been conditioned for NTSC

(National Television Systems Committee) color in the short period of about three years.

It also seems likely that most engineers not having close contact with television transmission are not aware of the extensive intracity networks which are necessary to interconnect pick-up points, control centers, points of connection to the intercity networks, television transmitters, etc.

The switching arrangements involved pose quite a problem. Not only must they be capable of almost instantaneous major rearrangements of both the inter- and intracity parts of the networks on cue or signal (to care for different pickups, insertions of commercials, etc.), but they must do it without upsetting the precise attenuation and phase adjustments required over the whole 4+ mc band.

At the other end of the television transmission scale is a rapidly growing requirement to transmit stationary (or very slowly moving and usually rather simple) pictures for display on the face of a tube at a remote point. For example, the banking industry may want tellers at remote points to be able to compare signatures or check bank balances from central records; other industries may want to read meters or check numbers or other things at remote points.

The latter phase of television transmission is just being created. The extent of its growth and what kinds and numbers of circuits it will require when it has achieved full growth are questions still to be answered.

Data Transmission. The technical (and the lay) press these days is full of news of "electronic brains." While one is permitted to have his own opinion as to whether or not these machines are, in fact, brains, at least one must admit that they can absorb data, compute, and spill out results at an astonishingly high rate.

There will be a growing need to feed data to them from remote points and most (but not all) of them require data in the form of pulses. Inasmuch as the number of circuits and the times needed to transmit a given amount of data depend on how many pulses per second the circuits will carry, there is a great urge to use the highest pulse rate practicable.

Transmission of pulses (particularly fast ones) poses more severe problems than transmission of speech, especially since the so-called "brains" have only a very limited capacity to detect and make correction for errors in transmission. Thus, the right number of pulses of the right wave shape must be transmitted and these pulses must arrive at the right times. The problem is somewhat analogous to television transmission although the speeds (so far at least) are much slower, and much narrower bandwidths are adequate.

ENGINEERING

THE SECOND LEG of the tripod is engineering. It should be clear from the foregoing that engineering in the telephone operating companies is far from a humdrum application of standard pieces to a standard pattern. And in the practical everyday world, no one part of the engineering job can operate in a vacuum; every part, including transmission, must be co-ordinated with every other part.

This engineering work has many phases and is organized differently in different companies. But however it is organized, it is directed to one objective, the fashioning of a plant which, in the long run, will give the best possible performance at the lowest possible cost now and in the future.

As a group, the several thousand engineers in the telephone industry are responsible for buying a billion or more dollars worth of plant each year with money which belongs to the owners of the business or is owed to people who have lent money to the business. The plant these engineers buy today—and every day—determines in large measure how good the service will be, how satisfied the people who put up the money will be, and how satisfied the customers will be, for many years. These engineers must, therefore, look at every job they do from this standpoint; they need to do the best possible job for the future as well as for the present, or else they may save a nickel today at the cost of a dollar tomorrow, or they may spend a dollar today which will be worth only a nickel tomorrow.

This sort of job involves as much creative imagination and forward thinking as the development of the instrumentalities themselves. In fact, the creative imagination and forward thinking on the part of the operating company engineers must go beyond merely making the best possible use of what is at hand—it must guide the development of the instrumentalities that are needed to do the future job.

It is still true that necessity is the mother of invention. And while it may not be true that research is the father, it is certainly true that the most valuable inventions are those which most adequately co-ordinate what the field says it needs and what research says is possible.

Thus, the operating company engineers must fashion a structure with what they have, and they must visualize the structure they want to fashion for the future, and they must get the instrumentalities with which to fashion it. They are not primarily concerned with the individual bold ventures which capture the public imagination like the Transatlantic Cable or transcontinental color television transmission. These bold ventures are important, but even more important is the fashioning of an over-all system which will always do the best possible job for every customer wherever he may be and whatever he wants.

Because the over-all system which these engineers fashion must be long-lived, it and each of its parts must perform its functions in such a way as to provide the best possible service at the lowest possible costs for a long time to come regardless of what happens. Someone has said there are no facts in the future. This may be so, but there are some certainties. For example:

1. Quantities will be different from those now estimated.
2. Instrumentalities will be different from those now foreseen.
3. The scope and nature of customers' wants and needs, and the service which the industry will be called upon to furnish, will be different from what we now think.

In this atmosphere, the engineer must be able to plan on the basis of sound fundamentals and trends, and he must keep his thinking, and his plant, flexible so as to be prepared for whatever may happen. Some of these trends and the methods of keeping flexibility can be exemplified.

The astute engineer sees that historically the costs of electronic gear in relation to outside plant have gone down, and

that transistors, increasing know-how, and quantity production (along with a dwindling world supply of copper) should accelerate this trend. He plans, therefore, on the basis of minimum physical plant and the maximum use of electronic gear.

He sees that improvements in switching gear, improved methods of handling traffic, etc., together with improvements in telephones and other transmission instrumentalities have made radical changes in number, locations, and sizes of switching installations, and he knows that even more radical changes are in the offing. He again uses electronic gear to the fullest, because it can readily be moved whereas outside plant cannot.

He visualizes a rapid growth in transmission over his facilities of a wide variety of information other than speech—video, data, to name only a few—and he knows that it will be physically impossible to design a different form of transmission system for every different requirement. Therefore, he builds his structure to be the best practicable one for these forms of transmission as well as for transmission of speech.

Above all, he keeps his mind open, so that while something new may surprise him, it will not upset his entire plan.

To the extent that these things can be and are done, planning for the future can be almost as sound as if one knew what it would bring. But, in order to plan, the engineer must have vision and imagination and the courage to go around with his neck stuck out permanently. He will make mistakes, but at least he can be sure that the mistakes he makes by being too forward-looking will be much less costly to the business than the ones he would make by following tradition.

MAINTENANCE

THE THIRD LEG of the tripod is maintenance. It is all well and good to engineer and build a plant with boldness and imagination; in fact, the business would sicken and die if this were not done. However, regardless of how well the plant is engineered it will not fulfill its purpose unless it performs according to design hour after hour, day after day, and year after year. With a plant whose performance depends on electronic gear, the concepts of maintenance are as different from the concepts appropriate to a plant with only inert parts as are the concepts of engineering.

With inert plant, maintenance consists largely of seeing to it that the individual pieces are in good physical condition and are properly connected in the right places; "maintenance" is almost indistinguishable from "repair." Once electronic gear is added, however, problems involving adjustment are added; good physical condition is necessary but not sufficient.

The whole matter of adjustments is rather complex but can be looked at as directed toward accomplishing two functions:

1. Precisely matching very large total amounts of amplification to very large total amounts of loss at all frequencies within the range encompassed by the transmission system.
2. Keeping the automatic regulating systems (which are provided with most transmission systems) tuned up so that they will cause the amplification at all frequencies to follow precisely the changes in losses which occur because of changes in temperature or other conditions.

To get a rough idea quantitatively of what these adjustments must accomplish, let us take a look at a rather simple case: a 200-mile 12-channel *K* system in aerial cable, using a frequency range of 12 to 60 kc on the line. At average temperature the total conductor losses range from about 700 db at 60 kc to about 310 db at 12 kc; these losses are made up by amplification at the ends and in about a dozen intermediate repeaters.

On a hot summer afternoon the losses may increase above the average by about 35 db at 60 kc and 15 db at 12 kc (and by intermediate amounts at intermediate frequencies), and on a cold winter night the reverse condition would occur. Thus, the regulating system must not only swing the total gain at the top frequency by 70 db or so, but also swing the gain at each other frequency by precisely the right amount. Translating the db figure to a power ratio, the 70-db swing between summer and winter means that the total power amplification in the dozen or so amplifiers must change by a factor of 10 million.

The problem of having every adjustment right is further complicated by the fact that each of the possible adjustments interacts with the others. For example, it is always possible at any particular time to compensate for maladjustments in one part of a system by maladjustments in another part so that superficially the system seems to be performing correctly. But the difficulty when this is done is that as soon as the temperature or some other condition changes, or as soon as somebody somewhere corrects one of the maladjustments, the compensation fails and the circuits may be in worse shape than if nothing at all had been done. It must be realized, also, that the compensating maladjustments which have been made may be at points which are separated by many miles.

Thus, correct adjustment is a formidable problem. However, it is being solved more and more successfully in many places. The secret of doing it successfully lies not so much in increasing the skill of the people who make the adjustments as it does in increasing the understanding of the need to do the job right, and of the principles involved.

The job, then, rests more on people than on instrumentalities. Therein lies the problem—and the solution. People can be educated; machines cannot. While it is much more difficult to educate people than merely to train them, the rewards are correspondingly greater.

CONCLUSION

OBVIOUSLY in a brief review of this kind it has been necessary to skip over, or touch only lightly, many aspects of the over-all job. All that it has been practicable to do is to present a little of the flavor of the job which the people in the business have to do and the tools with which they have to work.

The job of giving constantly better and more pleasing transmission and of handling the constantly widening scope of the business is a big one; but then, it is only by meeting such challenges that progress is made.

Planning for Rapid Transit in the New York–New Jersey Metropolitan Area

F. H. SIMON

A discussion of rapid transit in the metropolitan area and the planning undertaken by the Metropolitan Rapid Transit Commission is presented. With an estimated increase in population of this area from 15 to 19 million by 1975, serious study must be given to future needs.

METROPOLITAN RAPID TRANSIT COMMISSION is a bi-state agency that was created by the legislatures of the States of New York and New Jersey. Its sole function, as specified in the legislation, is to "study present and prospective rapid-transit needs of the New York–New Jersey metropolitan area and develop, recommend, and report as soon as possible measures for meeting such needs."

TERMINOLOGY

FIRST, consider what is included in the category of "rapid transit" in this metropolitan area. The terminology is rather loosely used, adding considerably to confusion on the subject in the minds of laymen. The terms "mass transit," "mass transportation," and "public transit" are general terms, used interchangeably, in reference to systems of common carrier facilities, offering service to the public for a fare and operating in accordance with schedules along designated routes with specified stops. Thus, these terms would include bus transportation, subways, elevated lines, and other railroads. Rapid transit is one type of mass transit, operating at a comparatively high average speed over exclusive rights-of-way with few, if any, crossings at grade. In this area, the definition restricts rapid transit to rail operations.

Over the years, the suburban services offered by main-line railroads were not considered to be rapid transit. As New York City experienced its tremendous growth, the suburban residential communities have become, in reality, merely extensions of the residential districts. A certain amount of commercial activity, notably retail merchandising and servicing trades, and an ever-growing amount of industry followed the population to the suburbs. As a result, the entire metropolitan area, which includes 22 counties, has become one economic entity, and even though it consists of scores of political units they are, nevertheless, completely interdependent. The suburban rail lines are now essentially a part of the area's rapid-transit network, in spite of the fact that many of them offer service only to commuters, operating no trains at all at other than commuter hours, and that the fare structure and other operating features have not been placed on the bases commonly accepted for rapid transit. In the light of modern standards, there are some people who might object to the use of the word "rapid" in connection with some of the suburban railroad services.

In examining the "needs" for rapid transit, both present and prospective, it is necessary to clarify the role of rapid transit in the community and to determine whether the existing system is adequate to fill that role.

The lifeblood of the New York–New Jersey metropolitan area, the greatest industrial and commercial center in the nation, is "communications" and, specifically, in this case, the expeditious movement of people to, through, and within the community. The network of rapid-transit lines and suburban railroad lines has been, and still is, the most efficient and economical means of moving people within the community. As a result, up to 25 years ago, the growth of New York City itself was centered along its transit lines, and the growth in the suburban areas was centered along the railroad lines offering commuter service.

AUTOMOBILES

SINCE THAT TIME, however, as the country has become automobile-conscious, there has been a dramatic shift in the travel pattern of people from the use of public mass transit to the use of the private automobile—from the use of the most efficient transportation medium to the use of the least efficient.

To illustrate this shift in the New York area in recent years, consider the annual movement of passengers across the Hudson River, for which comparative figures are available. In the 10 years, from 1945 to 1955, the number of railroad passengers declined from 141.3 to 72.5 million, or by 68.8 million. During the same period, the number of passengers using automobiles increased from 57.4 to 136.5 million, or by 79.1 million, and the number of passengers using buses increased from 55.8 to 67.3 million, or by 11.5 million; and in that period the total movement increased by only 11.9 million passengers.

The community was not prepared for this shift with the result that the streets of our urban centers, as well as the roads leading to them, became clogged with vehicles moving at a snail's pace. It became necessary to provide, at a staggering cost, bridges, tunnels, highways, superhighways, parkways, expressways, thruways, etc. In fact, total highway expenditures—Federal, state, local, and city—during the 25 years from 1929 to 1954, totaled $72,689 million, with $6,280 million spent in 1954 alone.

Full text of an address presented at the AIEE New York Section meeting, May 15, 1956, and recommended for publication by the AIEE Committee on Land Transportation.

F. H. Simon is with the Metropolitan Rapid Transit Commission, New York, N. Y.

One result has been to attract more and more people to the use of the private automobile, adding more and more to urban traffic congestion and increasing the demands for more and more highway expenditures. Even with the fine network of highways and Hudson River crossings, the Port of New York Authority recently stated "the demands on our principal arterial highways, bridges, and tunnels have far outstripped their capacities."

And the end is not in sight. The Clay Committee estimated highway needs for the next 10 years at $101 billion. The Port of New York Authority–Triborough Bridge and Tunnel Authority program for arterial facilities totals some $600 million. New York State highway needs for 10 years are put at $750 million. Westchester County wants to spend $65 million on its parkways. The country is "highway happy."

All of this is to expedite the movement of vehicles, which are the least efficient and economical means of transporting people. One lane of expressway traffic will accommodate only about 2,500 passengers per hour, whereas one lane of rapid-transit railroad can accommodate up to 60,000 passengers per hour, depending upon the number of standees. Also, an automobile carries an average of less than two passengers and requires from 200 to 350 square feet of parking area at its destination.

Concurrently with these developments, the metropolitan area's rapid-transit system has been in a state of stagnation or, worse, in a state of retrogression.

SUBWAYS

In New York City, only one major subway extension has been opened in years. In 1951, the people approved in referendum the provision of $500 million, outside of the city's debt limit, to construct a Second Avenue trunk line subway system and to make improvements on existing subway lines. The New York City Transit Authority has seen fit to expend a major portion of that authorization for absolutely necessary replacement of obsolete rolling stock and rehabilitation of power plants and other equipment and, thus, to defer construction of the Second Avenue Line. The only major transit extension constructed with these funds is the line to the Rockaways on Long Island, opened in June 1956, and this project, which had been in the negotiation stage since 1932, would not have been accomplished if the Long Island Rail Road trestle over Jamaica Bay, which burned in 1950, had been restored by the railroad.

RAILROADS

Referring to the suburban railroads, the service offered to the public, in many cases, is inadequate and inconvenient and not at a standard which would allow it to be competitive with private automobile or bus transportation. Trains, except in the peak commuting hours, are not operating at frequent intervals; the cost is high; and the service is inconvenient. Most commuters from New Jersey must leave the trains in New Jersey, take a ferry to the west side of Manhattan, and then either walk or use a transit line to reach their ultimate destination.

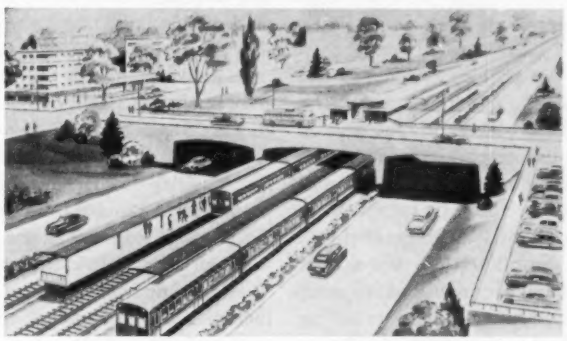
Local rail transportation, from suburb to suburb, is practically nonexistent, as the railroad lines were designed to carry suburbanites into New York City and not from point to point within the suburban areas. There are a great many suburban areas which are intensely developed, but which are not served by rail transit, as the railroad companies have not seen fit to extend their lines to tap these sources of traffic. One can hardly recall any extension of suburban rail facilities in the metropolitan area.

DECLINE IN RAIL PASSENGERS

Commuters have been attracted to automobiles and buses, so the railroad companies have found it necessary to increase fares and to reduce service in order to keep deficits within tolerable limits, thereby causing more of their passengers to desert them.

This has been a continuing vicious cycle, until the passenger traffic on those railroads has been reduced to almost the hard core of the morning and evening commuters who cannot, or will not, drive to work because of traffic and parking conditions or who do not have automobiles available. To handle such traffic is inherently inefficient. The railroads must provide and maintain sufficient plant and equipment to accommodate the peak traffic, morning and evening, which moves in a period of about 5 hours in the day. The other 19 hours of the day, the equipment fails to earn any substantial revenue, but still incurs large expense for capital charges, depreciation, maintenance, etc.

Faced, on the one hand, with constantly rising costs and loss of traffic to subsidized competitors whose tax-free rights-of-way are provided by the expenditure of public funds and, on the other hand, with restrictions on the managerial functions imposed by public regulatory bodies, the railroad companies are more than anxious to get out of the passenger business. The New York Central Railroad requested permission to abandon all passenger service on their West Shore line and all ferry service; then the Lackawanna Railroad petitioned to abandon all passenger service on its Boonton Branch; and the Susquehanna Railroad recently petitioned for sus-



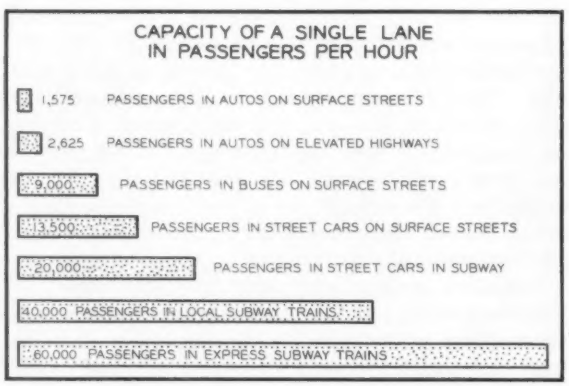
Courtesy General Electric Company

Fig. 1. Artist's conception of Chicago's Congress Street Expressway, which incorporates rapid-transit lines in a center mall, thus securing tremendously increasing capacity at negligible increase in cost.

pension of all passenger service. Many of the railroad ferry services have disappeared, the most recent being the Lackawanna's Christopher Street ferry, which suspended last year. These events are only forerunners of an increasing demand by the railroads to be relieved of the responsibility for providing suburban commuter services.

This most efficient means of moving people cannot be allowed to disappear. In 1954, there were 75.314 million passengers who crossed the Hudson River by railroad facility. If the railroads had been out of the passenger business and the passengers divided one third to buses and two thirds to automobiles (which was the 1954 division of trans-Hudson passengers other than railroad passengers), the trans-Hudson vehicular traffic would have been increased by about 813,800 bus crossings and about 32.476 million automobile crossings, enough to saturate two more Lincoln Tunnels. The cost of the additional tunnels, connecting highway facilities, and facilities to handle the additional traffic in our cities would be staggering—and the construction cost of tunnels today is such that revenue from tolls at the present levels probably would not be adequate to service the debt.

Also, what would happen to the City?—there are about 75,000 daily railroad commuters into New York City from the New Jersey side of the Hudson River alone. Without


CAPACITY OF A SINGLE LANE
IN PASSENGERS PER HOUR
1,575 PASSENGERS IN AUTOS ON SURFACE STREETS
2,625 PASSENGERS IN AUTOS ON ELEVATED HIGHWAYS
9,000 PASSENGERS IN BUSES ON SURFACE STREETS
13,500 PASSENGERS IN STREET CARS ON SURFACE STREETS
20,000 PASSENGERS IN STREET CARS IN SUBWAY
40,000 PASSENGERS IN LOCAL SUBWAY TRAINS
60,000 PASSENGERS IN EXPRESS SUBWAY TRAINS

Courtesy General Electric Company

Fig. 2. Relative passenger-carrying capacities of various means of transportation.

railroad service, 30,000 additional automobiles would be funnelled into Manhattan daily to serve commuters, and this would require bumper-to-bumper parking space totaling both sides of 50 miles of Manhattan's streets and avenues—so that traffic congestion would be intolerable.

In 1953, the Citizens Traffic Safety Board estimated that the cost of traffic congestion in New York City was a little over $1 billion annually; for the entire metropolitan area, probably, it would total $2 billion annually.

Another factor to be considered is the expected increase in population in the foreseeable future. The Regional Plan Association (Bulletin No. *85*, November 1954), estimated that the population of the metropolitan area will increase from 15 million in 1954 to 19 million in 1975. Serious thought must be given to the problem of moving these additional people in the most efficient manner—by rail—or else it will be impossible to accommodate such an increase of population.

For the good of the community, the decline of rail passenger service must be stopped—in fact, the trend must be reversed. There must be no public illusion—the choice is not between, on the one hand, keeping what there is or, on the other hand, getting something better. Actually, the choice is between a continuous worsening of what there is or going all out for the best.

PLANNING

No large metropolitan area can live without transit; and no transit can live without planning and adequate financial support.

Although the Commission's legislative mandate is limited to conducting a study of the area's rapid-transit needs, and although its primary emphasis is on planning for rapid-transit improvements, it realizes that the real problem facing the public is the solution of the area's total transportation needs—by rail, bus, and private automobile, with each mode of transportation so integrated into a regional transportation plan that it can make its maximum contribution to the public interest. In that way only can an adequate regional transportation system be provided at the lowest possible cost, and in that way only can the public be best served.

The Commission does not advocate that rapid-transit facilities be improved to the exclusion of highway improvements and, conversely, it calls on others not to exclude rapid-transit improvements from the elaborate schemes for the area which are being publicized almost daily.

It is fully as unrealistic economically to insist on the use of the private automobile as a substitute for mass transportation in planning for the development of the metropolitan area, as it is to insist on mass transportation as a substitute for the private automobile.

In spite of what has been said many times by planners and other experts, the problem is not one of movement of people or of movement of vehicles—but one of movement of both people and vehicles.

There must be restored a balance in, and co-ordination of, thinking, planning, and expenditures for facilities for the movement of private automobiles and buses, and for mass transportation by rail.

In line with its mandate, it is the task of the Metropolitan Rapid Transit Commission to find and propose ways to reverse the retrogression of suburban rapid-transit service and facilities—to develop a plan for a reinvigorated metropolitan-wide rapid-transit system, capable of sustaining the daily flow of executives, workers, shoppers, and visitors on which depends the vitality and prosperity of the area.

To accomplish its purpose, the rapid-transit system to be included in the regional transportation scheme must be so conceived and designed as to be competitive with the private automobile. The mere provision of transit facilities will not cause automobile drivers to leave their cars in the garage and use the trains and buses. Rapid transit must utilize the latest technology to provide comfortable cars,

adequate and convenient service, speed, and economy. Its routes must be so laid out as to meet the public's necessity for easy access to the line in residential areas and convenient distribution throughout the business districts.

This means, among other things, that passengers who travel longer distances will be provided with seats, although it is patently impracticable to provide seats for all passengers in Manhattan and the close-in contiguous areas. Also, midday train headways should be reasonably short; trains be operated at high speeds, averaging 40 to 45 miles per hour, including stops; stations in suburban residential areas be served by good local roads and by feeder bus lines; adequate parking facilities be provided at stations; stations in the business sections be within a reasonable walking distance of desired destinations; and, above all, the line be safe. It means that use must be made of every feasible mechanical or electronic device that can be developed for automatic operation of the system. It means that maximum use must be made of existing facilities and existing rights-of-way, and consideration be given to providing facilities for rail rapid transit in connection with the construction of grade-separated highways.

COMPREHENSIVE STUDY

SOON AFTER the Commission was formed, in the Summer of 1954, by action of the Legislatures of New York and New Jersey, it recognized the magnitude of the task which lay ahead, the complexity of the studies, and the amount of financing which would be required. At an early date, the Port of New York Authority, being concerned with means of improving the movement of passengers as well as freight in the New York–New Jersey port district, and realizing the magnitude of the task confronting the Commission and its limited resources, offered to finance that part of the Commission's comprehensive survey as would pertain to the problems of interstate rail transit between northeastern New Jersey and New York City. The Commission accepted the offer and after extensive negotiations the Commission and the Port Authority drafted specifications for the necessary surveys and entered into an agreement to carry out the most comprehensive study ever undertaken of the New Jersey–New York interstate rail transit problems. The studies were planned without any preconceived conclusions as to the interstate transit requirements or the best means of accomplishing the objective of improving rail transit service. The part of the Commission's study encompassed in the agreement is well under way by five groups of engineers and experts under the co-ordinating direction of Project Director, A. W. Page. It is estimated that the cost of this part of the Commission's study, to be borne by the Port Authority, will be $800,000.

However, the movement of people between New Jersey and New York is only one part of the transit requirements of the metropolitan area. The Commission found it necessary to ask the Legislatures of both States for additional funds to finance studies of the problem of the movement of people by rail between the Westchester, Long Island, and Staten Island sectors and the other sectors of the metropolitan area, and the movement of people by rail locally within each sector.

Appropriations of $150,000 from each State were made available during the past year and such studies are now also under way. They, too, have been placed under the direction of Mr. Page as project director for all of the Commission's studies.

Except for Staten Island, and those few cases in which the lines of the New York City Transit Authority will be considered in connection with the movement from the suburbs, the Commission will not study extensions to the existing rapid-transit system of New York City. For that purpose, Mayor Robert F. Wagner of New York City designated, on March 26, 1956, a Committee of high municipal officials under the chairmanship of C. L. Patterson, chairman of the New York City Transit Authority, and directed the Committee to co-ordinate the results of their activities with the studies of the Commission.

At the conclusion of the various surveys and studies, the results will be co-ordinated into a comprehensive report to be submitted by the project director to the Commission. After receipt of the report, the Commission plans to conduct public hearings throughout the area on the recommendations submitted by the consultants and, thereafter, will make the policy decisions which will be the basis of its final report to the Governors and Legislatures of New York and New Jersey.

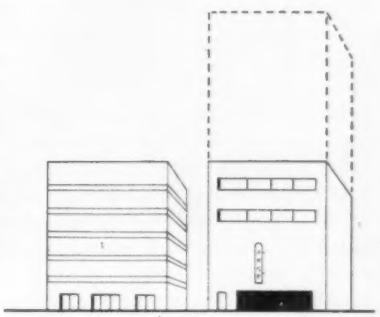


Fig. 3. Drawing shows average garage space required if everyone in nearby business establishment drove to work. Dotted line indicates added parking space needed for customers.

Courtesy General Electric Company

What will come out of this great co-operative effort, one can not now, as yet, be so presumptuous as to predict.

One thing must be realized—the Commission will not provide any cheap panaceas for rapid-transit problems. The Commission will not solve the rapid-transit problems. An agency such as this Commission is a tool of the public to be used for the proper planning of transit improvements. But trains do not run on plans, no matter how grand. The solution of the problems lies solely in the hands of the public itself. The Commission will not determine which, if any, of its plans will be put into effect. That decision will be made by the public who will be asked to vote for or against the recommended plan and who will ultimately pay the bill, either directly or indirectly—and the bill will not be a small one.

But no matter what the cost, the investment would return to the public a far greater sum in savings, both tangible and intangible. Therefore, the public can not afford not to pay the bill.

Experience with the Triple-Diametric Rectifier

R. V. WACHTER
MEMBER AIEE

C. S. HAGUE
ASSOCIATE MEMBER AIEE

C. R. MARCUM
MEMBER AIEE

IN HIS ENDEAVOR to meet the ever-present demand for improvements in electrical equipment the engineer usually explores new ideas and may overlook the advantages of old ones in the light of interim developments. Such has been the case for the triple-diametric circuit which offered little if any advantage 30 years ago with multianode rectifiers. When used with modern single-anode rectifiers, however, it offers over-all advantages for some applications when compared with the conventional double-wye circuit.

Fig. 1 compares the practical parameters of the two circuits for a 6,000-ampere 750-volt unit. The favorable factors of lower peak current, lower rms secondary phase current and lower arc-back current must be weighed against the disadvantages of higher inverse voltage and increased transformer capacity.

Although the kva ratings of the triple-diametric transformer windings are greater than those of the double wye, principally because of the larger interphase currents, the lower rms secondary current permits smaller copper cross sections and the bracing requirements are reduced. The anode breaker gains from the lower rms current but must interrupt against a higher inverse voltage. Since the breaker is applied over a range of voltages there are, again, many applications where the increased secondary voltage will be below the rating of the breaker.

An experimental transformer rated 10,000 amperes, 750 volts has been connected to existing rectifiers and installed in parallel with existing double-wye units on a 72,000-ampere potline. Simulated arc-back tests show that total fault current at the time high-speed anode breakers become effective is greatly reduced. On a per-unit basis, peak anode fault is only approximately 21 times normal rms for the triple diametric as compared to 35 times normal for the double wye. This reduction in fault current results, principally, from the higher reactance in the triple diametric for a given voltage regulation and from the inductance of the interphase winding which effectively blocks d-c contribution to the fault for the first major fraction of a cycle.

Arc-drop measurements on identical tubes for both modes of operation show the triple diametric to be approximately 1.5 volts lower for the same average anode current.

At the completion of arc-back and arc-drop tests the 7,500-kw experimental unit was subjected to actual operating conditions on the potline for several months. The unit shared load with paralleled units according to its inherent voltage output which was such that current output stayed between the limits of 9,600 and 10,200 amperes. In spite of the fact that the tubes were operated at approximately 167 per cent of their double-wye rating, satisfactory operation prevailed with only a moderate increase in arc-back frequency.

Although the circuit has some detrimental characteristics, these are not serious. Its advantages for certain applications far outweigh the disadvantages. In general, the application of the circuit on large installations in electrochemical service will enable the accomplishment of a given d-c bus rating with fewer rectifier assemblies and associated equipment. This will result in smaller building space requirements, reduced installation expense, and lower maintenance costs.

Because of these advantages, coupled with the reduction in magnitude of arc-back current that is a characteristic of this mode of operation, equipment utilizing this circuit is now being manufactured to furnish d-c power for three large electrochemical installations totaling over 200,000 amperes.

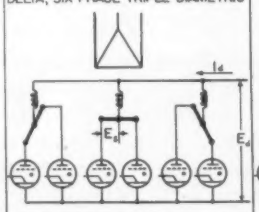
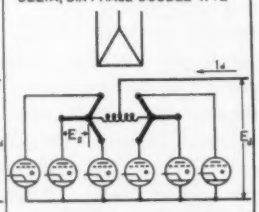
CIRCUIT	DELTA, SIX PHASE TRIPLE DIAMETRIC	DELTA, SIX PHASE DOUBLE WYE
		
RATED D-C VOLTAGE E_d	750 VOLTS	750 VOLTS
RATED LOAD CURRENT I_d	6000 AMPS.	6000 AMPS.
LOAD POWER P_d	4500 KW	4500 KW
PEAK ANODE CURRENT	2000 AMPS.	3000 AMPS.
AVERAGE ANODE CURRENT	1000 AMPS.	1000 AMPS.
RMS ANODE CURRENT	1414 AMPS.	1732 AMPS.
D-C WINDING VOLTAGE E_s	883 VOLTS	680 VOLTS
INITIAL INVERSE VOLTAGE E_{ii}	1153 VOLTS	772 VOLTS
PEAK INVERSE VOLTAGE E_{pi}	2500 VOLTS	1670 VOLTS
COMMUTATING ANGLE u (NO DELAY)	27.5°	27.5°
CREST ARC-BACK CURRENT-ONE GROUP	35,700 AMPS.	61,200 AMPS.
TRANSFORMER WINDINGS RATING	6400 KVA	6040 KVA
INTERPHASE EQUIVALENT RATING	870 KVA	320 KVA

Fig. 1. Comparative chart of the parameters of the triple-diametric and the double-wye power circuits

Digest of paper **56-186**, "Test and Operating Experience with the Triple-Diametric Rectifier," recommended by the AIEE Committee on Industrial Power Rectifiers and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 30–February 3, 1956. Published in AIEE *Applications and Industry*, March 1956.

R. V. Wachter is with the Aluminum Company of America, Wenatchee, Wash.; **C. S. Hague** and **C. R. Marcum** are with the Westinghouse Electric Corporation, East Pittsburgh, Pa.

Two New Total Radiation Pyrometers

W. DERGANC
ASSOCIATE MEMBER AIEE

S. N. HOWELL

THE MEASUREMENT AND CONTROL of temperature is basic to all industrial processes. Modern automatic machinery exploits the economy achieved by a continuous flow of product, as such machinery requires instrumentation capable of measuring the temperature of moving material in process for efficiency. Total radiation pyrometers are useful for this purpose, and there is a continuing demand from industry for more sensitive, accurate, and versatile instruments.

Two new pyrometers, applicable to a wide variety of industrial and laboratory measurements, are described, which combine good spectral response, high sensitivity, and rapid response, with stability and accuracy adequate for most requirements. These factors are discussed in relation to the design of the pyrometers. The basis for transferring a radiation measurement to a temperature by calibration, as well as some limitations, is considered.

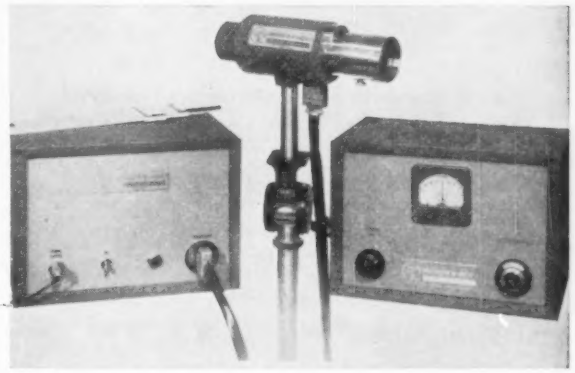
The first instrument, the "Servotherm" type *IR-2* radiation pyrometer system (Fig. 1), consists of a pyrometer head, amplifier, and power supply. This is a general-purpose unit for measurements in the range from 50 to 1,300 C and is capable of maintaining calibration under the ambient conditions encountered in manufacturing plants. The output is directly applicable to proportional automatic control systems.

Incoming radiant energy is collected by the Servofrax (arsenic trisulfide glass) lens and, after interruption by the mechanical chopper at a 15-cps rate, is focused on a Servotherm thermistor bolometer detector. This energy is compared with similarly interrupted energy from an internal reference radiation source via a second detector, which is bridge connected with the first. The bolometer bridge is biased with d-c voltages balanced to ground, and the cyclic interruption of the energy produces cyclic variations of the bolometer resistances. Any difference in energy levels between incoming and reference radiations produces an a-c voltage output from the bridge to the preamplifier grid.

After amplification, the output is rectified by a synchronous rectifier. This produces a d-c voltage polarity sensitive to the energy levels.

The internal reference source is always used to null the incoming radiation, making it possible to utilize full amplification for high differential sensitivity at all times.

The field of view of this system is 1° square, and the lens focuses from 1.5 feet to infinity. The system time constant, once set at a given temperature, is approximately 250 milliseconds. The instrument sensitivity at a temperature of 100 C is about 0.25 C, with full-scale meter deflection for ±6 C.



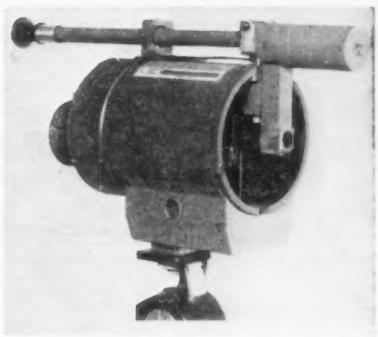


Fig. 1 (above). Type IR-2 pyrometer system showing power supply, left; pyrometer pick-up head, center; and amplifier unit, right. Fig. 2 (right). Type IR-1 pyrometer head.

The type *IR-1* system is a fast and very sensitive general-purpose laboratory instrument for measurements from ambient to 1,000 C. It employs essentially the same electronic system as the *IR-2*, but has a different pyrometer head, as shown in Fig. 2. In this system, incoming energy is collected by a first surfaced spherical mirror. The energy is interrupted by a motor driven chopper at 180 cps and focused on a thermistor bolometer detector. The output is proportional to the difference in radiant energy between the chopper, radiating at ambient temperature, and the incoming radiation. Focusing is accomplished by moving the detector-preamplifier assembly; and a scale covering from 2 feet to infinity is provided. The system covers a 1° square field, and the over-all response time is 25 milliseconds.

A feature of this unit is the parallex-free periscope sight which permits accurate aiming, when looking for hot spots, etc. The sight contains a built-in output meter so that simultaneous viewing of target and output signal is possible. Illumination balance is achieved by a controlled meter light and adjustable polaroid filter discs for the target.

Digest of paper 56-98, "Two New Total Radiation Pyrometers," recommended by the AIEE Committee on Instruments and Measurements and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 31–February 3, 1956. Scheduled for publication in AIEE *Communication and Electronics*, 1956.

W. Derganc and S. N. Howell are with Servo Corporation of America, New Hyde Park, N. Y.

Electronics Looks at the Future: *A West Coast Evaluation*

H. L. HOFFMAN

The rapid growth of the electronics industry is predicted to be doubled in size during the next decade. In answer to questions regarding evaluations of our national and West Coast television expansion, the author presents his opinions, as well as facts and charts, on growth in this field during the next ten years.

ELECTRONICS is unquestionably one of the world's most versatile and rapidly expanding industries. In addition to its more familiar products such as radio, television, record players, tape recorders, and other home entertainment devices, even the layman is gradually becoming aware of the wide range of electronic equipment. These encompass such broad classifications as wireless communications, detection and distance-measuring equipment, computers, navigational aids, industrial aids, industrial controls and checking devices, and the variety of other products which employ vacuum tubes or the newer solid-state devices.

NATIONAL GROWTH

What is the outlook for national growth in the electronics industry in the next 5 years? In the next 10 years? The electronics industry, at present, is as nearly diverse as its scope is broad. In the United States, it provides employment for more than 1 3/4 million persons; in fact, one out of every 40 persons employed today, or 2.7 per cent of our working population, is employed in the electronics industry. Of even greater significance is the fact that 75 per cent of the jobs filled by these people did not even exist a scant 10 years ago.

At the end of 1955, the electronics industry was producing equipment and services at an annual going rate of approximately $9 billion. Included in this total are the cost of home entertainment devices along with their repair and service, broadcasting and television revenue, industrial and commercial electronics, and defense electronics. The grand total for the industry has increased 81 per cent since 1950. By 1960, the industry total is expected to reach $15 billion, an increase of 55 per cent over 1955. A staggering 117-percent increase is forecast by industry experts for 1965.

In making any forecast as to where our industry is going in the next 5 years and in the next decade, each basic segment of the industry should be discussed separately.

First, consider the home entertainment phase of electronics. Last year was television's greatest year. More than 7.8 million receivers were manufactured—to set an all-time record. Retail sales were 7.4 million compared with 1954, the previous record year, when 7.3 million sets were sold to the public. Over 14 million radios were sold in 1955, plus more record players, high-fidelity units, and tape recorders than any other year to date. Table I illustrates the number of units sold and their dollar value for 1955, as well as estimates of the growth picture for 1960 and 1965.

Table I. Home Entertainment Devices* (in Millions)

	Unit Sales to Public			Manufacturers' Share of Retail Sales Total			Manufacturers' Share of Retail Sales	Distributors' and Retailers' Mark-up	
Year	Black and White	Color	Home and Auto Radios	Black and White	Color	Home and Auto Radios	Hi-Fi, Players Other		Total
1955	7.4	0.035	14.1	$1,013.2	$ 15.4	$318.0	$121	$1,174	$2,642
1960	5.0	3.000	15.4	550.0	795.0	$270.5	135	1,400	3,151
1965	4.0	6.900	18.4	320.0	1,380.0	$287.4	144	1,705	3,837

* Does not include repair or service.

Repairs and service of home entertainment devices show an even more amazing rate of growth, as given in Table II.

Since 1951, military electronics has accounted for the greatest percentage of the manufacturers' dollar volume at factory level, as well as an increasing percentage of the national defense budget. Military expenditures are expected to be well maintained in the foreseeable future, as shown in Table III.

Commercial and industrial electronics production is just beginning to come into its own and is expected to increase in importance throughout the next decade. The fields of instruments, X-ray equipment, and broadcast equipment have consistently represented the largest share of the total volume, but industrial equipment and controls are rapidly coming to the forefront. Growth expectations are shown in Table IV.

A healthy and rapid growth for every segment of the electronics industry can be predicted. From a total business today of almost $10 billion, this industry will double in

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H. L. Hoffman is with Hoffman Electronics Corporation, Los Angeles, Calif.

Table II. Repairs and Service Cost for Home Entertainment Devices (in Millions)

Year	Factory Sales of Parts	Distributors' and Dealers' Revenue on Parts	Service and Installation	Total
1955	$ 680	$ 450	$ 930	$2,060
1960	1,330	877	1,232	3,439
1965	2,330	1,538	1,685	5,553

Table III. Military Electronics

Year	Total Defense, Billions	Government Electronics to Total Defense, Per Cent	Military Electronics, Billions
1955	$33.2	7.4	$2.5
1960	37.0	8.8	3.3
1965	40.1	9.9	4.0

size in the next decade, exceeding $21 billion, as shown in Table V.

The total number of manufacturers of electronic end equipment, components, and hardware in 1955 was estimated at 3,600 by the Electronics Production Resources Agency. Of these, 1,000 firms produced end equipment or major subassemblies of some type in the entertainment, commercial, or military fields. Components manufacturers totaled an estimated 2,000, while the remaining 600 companies associated with the electronics industry produced such related hardware as antennas, brackets, switches, shafts, knobs, wiring harness, etc.

Despite the large number of companies in the industry, about 50 manufacturers are estimated to account for over 80 per cent of the dollar volume of end-equipment production, while the remaining companies supplied the necessary parts to build the end equipment. The major producers of components number between 150 and 200 firms.

WEST COAST ELECTRONICS

What is the outlook for growth of the electronics industry in the West? In California? In Los Angeles, Calif., electronics gives promise of becoming the largest industry in the area. The possible and probable applications of electronics in the factory, office, home, and in all aspects of our lives stagger the imagination.

At the present time, electronics, in the Los Angeles area, accounts for a substantially higher percentage of the national total in this field than in manufacturing as a whole. Unofficially, the city ranks second place nationally in the production of electronic equipment, exclusive of radio and television. It is the guided missile and electronic computer headquarters for the country. Even more significant is the fact that the Los Angeles area probably is in second place nationally as a center of electronic research and development. This offers particular encouragement for the future.

Close to 80,000 persons are currently engaged in producing electronic items in the Los Angeles metropolitan area. In other words, between 11 and 12 per cent of all persons employed in the manufacturing plants of the area are in some phase of electronics work.

During 1953, 1954, and the first half of 1955, the capital investment in new electronics plants and expansions, announced for Los Angeles County, totaled over $90 million. This was a larger total than for any other industry. It was nearly double the amount expended by the aircraft industry—amounting to 18.4 per cent of the total for all manufacturing industries combined.

In 1955, there were 436 firms in the Los Angeles metropolitan area manufacturing electronics products with an annual factory billing of $917 million. Even the most conservative forecasters agree that a $1 billion billing is assured for 1956.

Although 51 new firms were started in 1955, the total number of electronics companies in the Los Angeles area decreased by four for the entire year. Company mergers from within and outside the industry primarily were responsible for the slight numerical reduction of firms. This consolidation, however, resulted in strengthening the overall management and production capacity of local electronics industry.

Also significant in the total growth picture were the number of larger and more established companies that located manufacturing and research facilities in the Los Angeles area. Most of these companies manufactured a component line or rendered a research and engineering service that was greatly needed by local industry.

Contributing to the growth of the electronics industry in Southern California and the West will be the tremendous increase in population forecast for the next decade, as shown in Table VI. Such a population increase will necessitate a proportionate increase in educational and industrial opportunity. It is certain to heighten the demand for engineers of all kinds.

The West's greatest electronic growth will be in the new fields of nuclear energy, solar energy, missiles, satellites, communication, navigation, rockets, and countermeasures.

Table IV. Industrial and Commercial Electronics* (in Millions)

Year	Factory Sales	Distributors' and Dealers' Revenue	Total
1955	$ 659.0	$ 527	$1,186.0
1960	1,014.6	959	1,973.6
1965	1,329.6	1,500	2,829.6

* Includes broadcasting equipment, computers, industrial aids and controls, etc.

Table V. Electronics Industry, Total Sales (in Millions)

Year	Home Entertainment, Repairs and Service	Industrial and Commercial	Military Electronics	Broadcast and TV Revenue	Grand Total, Electronics Industry
1955	$4,702	$1,186	$2,460	$1,435	$ 9,783
1960	6,590	1,974	3,270	3,430	15,264
1965	9,389	2,830	3,950	5,460	21,630

Table VI. Population Growth (in Millions)

Location	1955	1965	Per Cent Increase	Total Increase
California*	13.0	18.1	40.0	5.2
The West	23.0	31.0	33.6	7.8
U.S.A.	163.0	191.0	17.12	28.0

* California gain is 66.24 per cent of the West Coast gain.

Also, the leadership in the advanced design and production of consumer service goods, such as computers and other data-processing equipment, should be maintained. As a matter of fact, the future growth of the industry in the West will be determined by the extent to which the engineers are able to develop strategic weapons and to create commercial products utilizing the new electronic arts.

There is some question as to whether the electronics industry will continue to grow at its present rate in Metropolitan Los Angeles. The pressure of the military's dispersal policy, as well as industry's personnel procurement, gives every indication of forcing an inland migration. The build-up in Arizona and Colorado are certainly indicative of this trend, although the extent to which it will continue is not as yet clear-cut.

What are the problems which must be solved to realize additional electronic growth in the West? Growth of electronics on the West Coast primarily is tied to the necessity of developing a higher creative content per dollar or per pound than other areas. This calls for a closer co-ordination between the scientific, academic, marketing, and manufacturing phases of our industry than has been the case in the past.

Another important factor in growth is a proper attitude of mind. Growth has occurred in the West because a problem is approached in a positive manner—thinking has not been influenced, diluted, or sidetracked by a philosophy of status quo.

New components, as well as new concepts, should be concentrated upon—for the environmental characteristics of a component in a television set are entirely different from those of a component in missile traveling at Mach 10 or 15.

Probably components, such as vacuum tubes, resistors, condensers, volume controls, etc., that already are being manufactured by established companies in the Midwest and East will never be produced to any degree in the West. The labor rates do not encourage this, and the mass market for these products primarily is in the geographical area where they are manufactured. There is little to be gained by either the supplier or the customer in moving this type of component production to the West Coast.

There is much to be gained, however, by creating the home base for the manufacture of semiconductors and engineered components in the West. Just as a resistor manufacturer in Philadelphia, Pa., can do a big business on the West Coast, a semiconductor manufacturer in California can supply New York, N. Y., and the Eastern Seaboard equally as well as he can serve the local industry. The yardstick by which the component is evaluated is the same as the yardstick used to measure the value of the end equipment. If the degree of engineering content contained in the product is superior, the market will follow.

MILITARY ELECTRONICS

How is military electronic production shared as to percentages for aircraft? Missiles? U. S. Navy? President Eisenhower's budget message to congress in January 1956 stated that there will be increased spending for military functions of the U. S. Defense Department in the next fiscal year, "emphasizing air-atomic power, guided missiles, research and development, continental defense, and the re-equipping of our forces with new types of weapons."

The President pointed out that about $6.8 billion of the new defense budget of $34.9 billion is estimated for aircraft procurement. "Expenditures for the procurement of guided missiles," the Chief Executive said, "will be the highest in our history, increasing by more than one third over 1956, and about double the amount spent for this purpose during 1955." He also indicated that "Expenditures for electronics and communications equipment will remain high during the fiscal year 1957, to meet the needs for continental defense and our combat forces."

The President said research and development spending will be somewhat higher in 1957 than during the current fiscal year. "Major emphasis will be placed on projects related to guided missiles, continental air defense, and the application of nuclear energy for the propulsion of aircraft and ships."

"It is my belief," he declared, "that increased returns in military research and development can be obtained through a relatively stable program at approximately the present level which can utilize effectively our scientific and technological resources."

A breakdown of the available funds and expenditures for aircraft, missiles, and electronics by the three services for 1955, 1956, and 1957 is shown in Table VII. In analyzing the figures given, it is important to realize that the totals labeled "Electronics" include only the small portion of the total electronic defense dollar that covers direct procurement of electronic equipment. The U. S. Defense Department does not break down the percentage of the aircraft dollar or the missile dollar that goes for electronic gear, but it would be at least one third of the aircraft dollar and approximately 50 per cent of the missile dollar.

The U. S. Defense Department also is asking for $1.5 billion to finance research and development activities of the three military departments for fiscal 1957.

In addition to the U. S. Defense Department expenditures for aircraft, missiles, and electronics equipment, the President has asked the Congress for an additional $18.6 million for air navigation, electronic and visual facilities, and aeronautical communications stations for the Civil Aeronautics Administration.

In evaluating the figures shown in Table VII, it is interesting to note that no appreciable reduction in piloted aircraft production is expected, at least for the present. Yet, no facet of our national defense program is more vital than the guided missile program. It appears that the problems of communication, navigation, countermeasures, test equipment, etc., are to be with us for some time.

It is true that the Air Arm of the United States has been given the highest proportion of the budget. This does not mean, however, that the U. S. Navy and the U. S. Army will not continue to play an important role in the country's over-all security program.

EXPANSION PROGRAM

How will requirements for expansion capital be met by the electronics industry? Need for expansion funds will be met the same way that they have been met for many years, namely: (1) by getting acquainted with local bankers, (2) through private commercial loans, and (3) through private investments. Undoubtedly there will continue to be more and more mergers in our industry as the present tax laws and procurement practices encourage them. However, the industry should not plan too long on progress payments.

How can the electronics industry develop better liaison with the customer, both commercial and military? Anyone who has anything to sell must first of all make it his business to know and understand his customer's problem. This basic rule applies whether that customer is the Government, another company, or an individual. It is equally true when one is selling a product or when one is selling a service. If one finds out the customer's problem and absorbs oneself in his problem—one is on the road to selling him. A customer is never interested in buying for the sake of buying, but he is looking for someone to handle a problem for him or do a job for him.

Professional associations and trade associations are all worth-while mediums to facilitate liaison with customers. The symposiums, programs, and just plain "get-acquainted" sessions of any of these groups are extremely valuable and useful in getting to know and understand customers better.

ELECTRONIC ENGINEERS

What are the engineering problems and opportunities ahead in electronics? One of the most critical problems facing industry today is how to get more engineering output in industry. Several things are necessary to accomplish this goal. First, engineering must be improved qualitatively. Management must make it possible for engineers to do engineering work—to spend the maximum amount of their time on engineering work and a minimum on miscellaneous paper work. One way this could be realized would be to establish a uniform drafting procedure for manufacturing drawings, that will be recognized and accepted by all three of the military services and by industry in general. This would reduce the number of engineering drafting hours by at least 30 per cent.

More concise and pertinent specifications would add further efficiency to the engineer's output. Industry, rather than the services, must take the lead in this because industry has, over the last 5 years, pretty well diluted the services' capabilities of handling such a problem by continually "raiding" top service personnel.

In the long-range picture, more engineers are needed. This means developing an interest in engineering and allied fields both in boys and girls at an early age. Something is needed in electronics equivalent in interest to the "hot rod" of the automobile industry and the model airplane of the aircraft industry. The "ham" radio operator helped pioneer the nonentertainment side of our business and is still an important factor in training young men for careers in electronics.

Table VII. Military Expenditures for Aircraft, Missiles, and Electronics (in Millions)

Facility	1955 Available Funds	1955 Expenditures	1956 Available Funds	1956 Expenditures	1957 Available Funds	1957 Expenditures
U. S. Air Force						
Aircraft	$2,480	$6,295	$5,476	$5,216	$3,826	$5,041
Missiles	219	305	700	485	1,422	799
Electronics	309	450	197	494	818	511
U. S. Navy						
Aircraft	$1,918	$1,676	$ 761	$1,561	$1,489	$1,600
Missiles	126	176	238	172	354	177
Electronics	96	159	151	82	191	104
U. S. Army						
Aircraft	$ 67		$ 103		$ 110	
Missiles	150		260		300	
Electronics	28		95		130	
Total Defense Department						
Aircraft	$4,398	$3,038	$6,237	$6,880	$5,315	$6,751
Missiles	345	569	938	917	1,776	1,276
Electronics	414	637	347	671	1,009	745

Industry must take more initiative in helping grade schools and high schools, not necessarily with money, but by furnishing equipment and manpower to assist in the training processes. If industry will actively co-operate with the schools in this manner, excitement and interest in engineering will be generated and much of the dismay and apprehension will be eliminated at the same time.

Engineering schools must also broaden their curriculum in order to develop more competent administrative engineers, as well as engineers who are equipped to solve top-level personnel, financial, and management problems.

Greater interest among engineers, as well as greater respect for careers in commercial electronics, should be developed. At the present time our emphasis is entirely too one-sided, for our long-range potential is in consumer, commercial, and industrial electronics. The military electronic dollar will always be subject to fluctuations because of international policy.

Opportunities exist today such as have never existed before for the engineer. Business no longer looks at engineering as a necessary evil. The engineer has become an essential element for the growth of any company, and his opportunities lie in practically any phase and in every type of industry.

What obligations do electronic engineers have to the industry? To the nation? In answering this question, John Jones, American citizen, rather than John Jones, engineer or salesman, will be discussed. This country makes a mistake by attempting to put a label on everyone and then set up a guidepost and house rules for the label rather than for the individual.

If anyone, as an individual, wants to get ahead and contribute something to the company for which one works or the nation in which one is a citizen, one again must lose oneself in one's job. A person must find out the interest

and the objectives of the company and tune himself in with these two factors. Teamwork is very important. Leadership comes only after teamwork is learned. Initiative is perfectly possible at the same time and pays big dividends, whether it be in engineering, salesmanship, or financial management.

What do you think engineers should stress in their training to equip them to handle positions of additional responsibility? First, every engineer should consider taking a course in public speaking. Engineers need not be inarticulate; nor should an engineer develop an inferiority complex because he has difficulty expressing himself. Yet, there are many engineers who seemingly find the task of expressing themselves an impossible hurdle.

Those who are still in college should not neglect this training for the future. If a working engineer finds it difficult to express himself, he should investigate the many avenues open for improvement of one's speaking ability.

Good ideas that cannot be expressed are like talented men unemployed. Public speaking makes one organize one's thoughts in informal conversation as well as when one is on the platform.

There are many other areas of study to be recommended to engineers interested in seeking positions of additional responsibility in industry. Courses in administration and management practices are essential, and equally important for an ambitious engineer to understand is marketing, finance, economics, and human relations. An engineering degree in itself is not a passport to success. Unlimited opportunities, however, exist for the graduate engineer who also has a well-rounded education, plus broad experience.

Dynamax—A New Crystal and Domain-Oriented Magnetic Core Material

G. H. HOWE

Dynamax, a new high-permeability magnetic material, developed in the form of thin tape for toroidal cores, has dynamic characteristics superior to those of any rectangular hysteresis-loop materials commercially available today. Most promising applications are in magnetic amplifiers and, possibly, in special transformers.

SEVERAL IMPORTANT DEVELOPMENTS in the field of magnetic materials have come from the nickel-iron system, notably the "Permalloys." Outstanding from the point of scientific interest were the results reported by Bozorth, Dillinger, and Kelsall[1] on their investigation of the effect of heat treating a series of nickel-iron alloys in a magnetic field. A large increase in permeability developed, the maximum value occurring in an alloy of about 65-per-cent nickel where the Curie temperature is highest in this nickel-iron composition range. Dahl and Pawlek[2] confirmed the large effect of cooling in a magnetic field using 12-mil thick nickel-iron strips both with random and preferred crystal orientations. Subsequent development of the alloys of this type and the controversy over the mechanism of magnetic annealing have been discussed by Hoselitz.[3]

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G. H. Howe is with General Electric Company, Schenectady, N. Y.

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EXPERIMENTAL WORK

THE INITIAL WORK in this investigation was directed at improving the magnetic properties of *65* Permalloy by making grain-oriented thin strip for test in wound toroids.

The alloy was vacuum melted in an induction furnace and poured into a cast-iron mold. To improve rolling, 0.3-per-cent manganese was added. The ingots were reduced to thin strip by hot forging, followed by hot and cold rolling.

After slitting to the desired width, the strip was coated with a thin film of hydrated magnesia and wound into toroidal test specimens. Following a 1,100 C preliminary anneal in pure dry hydrogen, the specimens were heated to 650 C in ordinary hydrogen and cooled in a magnetizing field of 10 to 12 oersteds at 150 C per hour. This treatment is called a magnetic anneal in this article. It should be noted, however, that it is slow cooling through the Curie temperature in a magnetic field.

The d-c magnetic properties shown in Table I are typical of those obtained on $1^1/_2$-inch inside diameter (ID) × $1^7/_8$-inch outside diameter (OD) cores wound with $^1/_2$-inch wide tape of different thickness and heat treated, as described in the foregoing. It is observed that: (1) Of the 5-mil specimens, Nos. 1, 4, and 5, maximum permeability improved with increased percentage of cold reduction.

(2) Referring to the second group of specimens, Nos. 3, 5, and 6, for a constant amount of cold rolling, 87½-per-cent cold reduction, the magnetic properties were improved by a decrease from 10 mils to 3 mils in finish thickness. The results of X-ray diffraction tests furnished evidence that the degree of preferred crystal orientation also increased with thinner material. (3) The data on specimen No. 6B illustrate the effectiveness of the magnetic anneal on this alloy. The maximum permeability is raised by a factor of 125 and the d-c hysteresis loop is squared.

Table I. D-C Magnetic Properties of 65 Permalloy

Heat	Specification Number	Thickness, Mils	Per Cent Cold Rolled	Normal Induction μ Max	Normal Induction At B	Hysteresis, Peak H=12 Peak B	Hysteresis, Peak H=12 B_r	Hysteresis, Peak H=12 H_c	X-Ray Diffraction
VH 506	1	5	98	976,000	7,750	13,375	12,700	0.0103	
	4	5	94	782,000	9,500	13,430	12,720	0.0111	
	5	5	87.5	700,000	10,100	14,080	12,400	0.0147	
VH 506	3	10	87.5	555,000	10,000	13,480	12,160	0.0143	No cube texture to any degree
	5	5	87.5	700,000	10,100	14,080	12,400	0.0147	Some cube texture
	6	3	87.5	1,027,000	9,400	13,350	12,840	0.0115	Primarily cube texture
VH 506	6B	3	87.5	8,420*	5,400	13,370	1,200	0.171	
				1,016,000**	10,100	13,530	13,020	0.010	

* 4-hour 1,100 C pure dry hydrogen preliminary anneal only.
** After magnetic anneal.

The extreme degree of magnetic softness attained in *65* Permalloy was not useful in a-c applications owing to the low (25 microhm-cm) resistivity of the binary alloy. To remedy this serious limitation, molybdenum was first added to *65* Permalloy to increase its resistivity as follows:

	Molybdenum by Analysis, Per Cent	Specific Resistance	Specific Gravity	Curie Temperature, C
VH 465	1	34	8.49	
VH 466	2.16	47.7	8.52	560
VH 561	2.9	54.1	8.63	540

While increased resistivity was attained at some sacrifice in d-c magnetic properties, reasonably high maximum permeability and low coercive force were measured on 2-mil × ½-inch wide tape from VH 466 containing 2.16-per-cent molybdenum, i.e., Specimen No. 466–4: 338,000 maximum permeability (μmax), 11,740 residual flux density (B_r), 0.029 coercive force (H_c), 47.7 microhm-cm. The dynamic hysteresis loop of this specimen at 60 and 400 cps was found to be narrower than that of "Deltamax" and *65* Permalloy. The 3-per-cent material was no better dynamically and had a lower saturation density.

In addition to 60- and 400-cps dynamic hysteresis loops, Specimen No. 466–4 was tested in a half-wave self-saturated magnetic amplifier circuit, and control characteristic curves were made at 60 and 400 cps. Results showed a marked superiority in relation to comparable data on Deltamax cores, except that the available power output range of the Dynamax core was only 75 per cent that of the "Deltamax" core. This difference is attributed to the lower saturation density of Dynamax.

Molybdenum was chosen as the alloying material for the following reasons: (1) It was known to raise resistivity more effectively than silicon for a given reduction in saturation density. (2) Its addition to *79* Permalloy had produced "Supermalloy," whose dynamic properties were excellent. (3) It might provide a means for easy nucleation of the domains and improve the dynamic properties.

METALLURGICAL DEVELOPMENT

THE DEVELOPMENT of good magnetic quality in Dynamax parallels that of producing other grain-oriented alloys in that variations in melting, casting, and hot working are reflected in the quality of finished strip.

Early in this investigation, ingots of square cross section were reduced to billets by hot forging and further to strip by hot and cold rolling. Good magnetic properties could not be reproduced consistently, so attention was focused on the structure of the ingots. A typical structure of the cross section of these ingots is shown in Fig. 1.

It was conceivable that an important variable lay in converting this columnar-cast structure into a uniformly optimum-wrought structure through progressive working

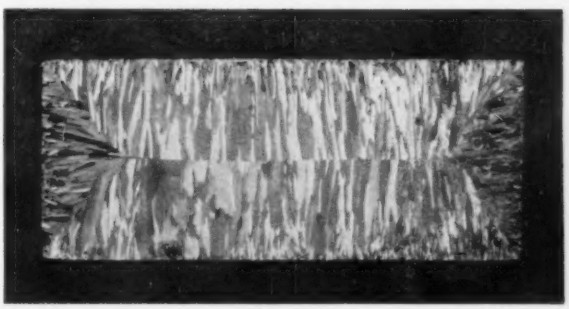

Fig. 1 (right). Cross section of vacuum-cast Dynamax ingot. Fig. 2 (below). Cross section of 1½×4-inch Dynamax slab cast in graphite mold.

under the locally applied forces of a forging hammer. Therefore, a $1^1/_2$- × 4-× 12-inch slab was cast in a split graphite mold for reduction solely by rolling.

Fig. 2 shows a typical cross section. The ingots being cast vertically, the columnar grains grew from all four sides with most of them perpendicular to the rolling plane.

The d-c magnetic properties shown in Table II were obtained on $1^1/_2$ ID × $1\ ^7/_8$-inch OD cores, wound with 2-mil × $^1/_2$-inch wide tape, produced by rolling a portion of the completely columnar-slab ingot.

In a previous experiment it was learned that a primary recrystallization treatment improved the magnetic quality. Table II, column 1, shows the effect of this treatment at various temperatures. It is observed that highest permeabilities were measured on tape which had been subjected to recrystallization at 700 C prior to the 4-hour high-temperature anneal and the magnetic anneal.

Reannealing 4 hours at 1,200 C, plus magnetic anneal, substantially increased the permeabilities of the prior recrystallized specimens, particularly No. 3B2 which attained 1,615,000 μmax.

The poorer properties of No. 3B1 and No. 3B2 after reannealing at 1,300 C can be explained by a difference in crystalline texture.

Specimen No. 3B3 measured 1,530,000 μmax after 4-hour 1,200 C pure dry H_2 (hydrogen), plus magnetic anneals. The d-c hysteresis loop of this specimen is shown in Fig. 3.

Table II. Effect of Annealing Treatment on D-C Magnetic Properties of Dynamax

No.	Initial Recrystallization Minutes	C	Normal Induction μ Max	At B	Hysteresis, Peak H = 12 Peak B	B_r	H_c
4 Hours at 1,100 C Pure Dry H_2+Magnetic Anneal							
3B1	10	500	800,000	9,200	12,440	11,490	0.0125
3B2	10	700	1,073,000	10,400	12,490	11,910	0.0096
3B3	10	900	1,036,000	10,200	12,590	11,980	0.0095
3B4	None		621,000	8,800	12,740	11,780	0.0150
4 Hours 1,200 C Reanneal Pure Dry H_2+Magnetic Anneal							
3B1	10	500	1,231,000	9,300	12,500	11,600	0.0077
3B2	10	700	1,615,000	10,100	12,640	12,020	0.0055
3B3	10	900	1,530,000	9,900	12,640	11,940	0.0055
3B4	None		723,000	9,500	12,630	11,880	0.0109
4 Hours 1,300 C Reanneal Pure Dry H_2+Magnetic Anneal							
3B1	10	500	449,000	8,900	11,090	10,280	0.0176
3B2	10	700	551,000	9,500	11,190	10,600	0.0124

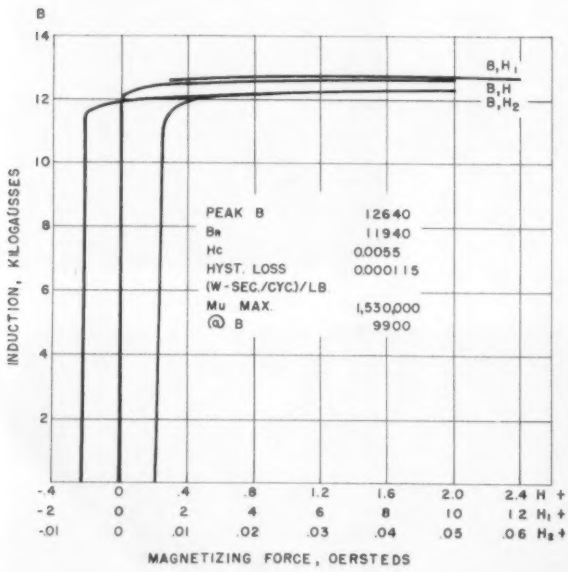

Fig. 3. D-c hysteresis loop of Dynamax, 2-mil×1/2-inch tape.

The best values which have been attained are 1,780,000 μmax, 11,950 B_r, and 0.0053 H_c. This maximum permeability is higher than any published values for a polycrystalline material.

DYNAMIC PROPERTIES

THE IMPROVEMENTS in dynamic properties obtained by the addition of 2-per-cent molybdenum to *65* Permalloy cannot be accounted for by the increased resistivity alone. This leads one to believe that the addition of molybdenum brings about a condition in the material which is more favorable to domain nucleation. Because it is believed that imperfections in the magnetic structure of a material are likely spots to form regions of reversed magnetization, i.e., reversal nuclei, it is not unreasonable to assume that the addition of molybdenum may affect the number and distribution of such reversal nuclei.

However, the static and dynamic hysteresis loops recorded by the U. S. Signal Corps on two specimens of Dynamax which had been processed differently indicate that there are processing effects which influence domain size and, therefore, affect the dynamic loop width. The specimen having the superior d-c properties of low H_c and high ratio of B_r to B_s was inferior dynamically to the specimen having the poor d-c properties. It is apparent that, as of now, there is no good explanation for this. The answer is expected to come from our further studies of this and similar alloys in search for rectangular core materials having improved dynamic properties.

Dynamax promises to be less sensitive to the effects of temperature variations than are the nickel-iron alloys now commercially available. The effect of core temperature up to 315 C upon the gain of a high-performance magnetic amplifier is about the same for Dynamax as it is for grain-oriented silicon strip cores.

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Automatic Dispatch System for Teletypewriter Lines

J. L. MAXWELL
ASSOCIATE MEMBER AIEE

H. K. FARRAR
MEMBER AIEE

AUTOMATION recently has been extended to teletypewriter services used for exchanging messages among stations connected by half-duplex (nonsimultaneous 2-way) multistation telegraph lines. The automatic dispatch system to be described virtually eliminates all station-attendant operations except one. Typing of the message is required to perforate a tape with the teletypewriter codes corresponding to the characters in the message. The attendant then inserts the tape in an automatic transmitter and the dispatch system does the rest.

In a multistation service it is important to be able to send messages to selected stations only. Otherwise all messages are reproduced at all stations. This wastes paper, eliminates privacy, and requires scanning of all messages at each station. Some services have included manually operated selecting equipment, thus providing privacy and saving paper. But, in all cases, it has been necessary for attendants to observe line lamps to avoid trying to send a message during transmission of another. Even this did not always prevent two or more simultaneous attempts to use the line. In such cases, of course, unsuccessful attendants had to resume watching and waiting. In addition, manual selection of stations required appreciable line and attendant time.

The new automatic dispatch system practically eliminates nonproductive line and attendant time. The new system also provides for priority handling of urgent messages. Operation of a key at a station causes messages at other stations to be held until after that station has sent its message.

The teletypewriter automatic dispatch system (TADS) is sufficiently flexible to permit meeting widely different requirements. All stations include a page-printing teletypewriter, a keyboard tape perforator, an automatic transmitter, and a selector. The page printer is used to receive messages from other stations. The perforator is used in preparing tapes of messages to be sent. The perforated tapes are inserted in the transmitter which is started automatically. Under control of the tape, the transmitter sends messages at 60 or 75 words per minute. The selector consists of relays and other circuit components connected to several pairs of contacts added to the teletypewriter to close circuits in response to certain codes. The selector, in response to its selecting code, connects the associated teletypewriter to the line to receive messages. It also starts the automatic transmitter upon receipt of its start code from the controller when tape is in the transmitter.

One station per line, the master station, includes a controller in addition to the other equipment. It consists chiefly of a rotary stepping switch and relays. The controller polls all stations for waiting messages by sending station start codes in a predetermined sequence to start transmitters containing tape. Heavy-usage stations can be included more than once in the polling cycle.

Twenty letters of the alphabet are used as station codes. The letters *V*, *M*, *O*, and *T* are not used as they are occasionally generated by accidental opening and closing of the line. The letters *H* and *S* are used for other functions. These reservations limit the normal number of stations per line to 20 when single-digit codes are used. To permit more than 20 stations per line, 2-digit coding has been provided, allowing 36 stations per line.

Available intercepting equipment includes a reperforator (receiving perforator), a station selector, control relays, and a panel equipped with a lamp and key for each station. It is intended for use at the master station. The reperforator automatically produces tapes of all messages with nonvalid station codes or incorrect format. Operation of a station key will cause similar interception of all messages correctly addressed to that station.

During polling of the stations for waiting messages, the station lamps in the intercept equipment light as each station start code is sent. During transmission from a station or when the intercept key for a station is operated, the corresponding station lamp stays lighted.

Push-button selecting equipment provides for sending single-digit selecting codes for any of 20 stations or for manual or automatic relay equipment. Use of this equipment makes it unnecessary to perforate station codes in message tapes and simplifies the message format. Push-button operation has advantages when it is desired to require attendants to follow a simple message format. In addition, it is advantageous when it is necessary to send tapes received with no directing codes or with incorrect codes.

Equipment is available for manual relaying of messages among several lines. In such cases each line is equipped with a reperforator at a point where all lines appear. Each reperforator has a selecting code permitting it to be selected to receive messages which are to be sent to a station on another line.

Automatic relaying of messages between two lines is also available. This requires a combination reperforator and automatic transmitter on each line at the relay point. Each reperforator-transmitter receives messages from one line and transmits them to the other line in response to start codes from that line.

The widespread adoption of the TAD system has emphasized the need for automation of moderately extensive teletypewriter services. Economies in attendant time and greatly increased circuit efficiency are achieved.

Digest of paper **56-646**, "Automatic Dispatch System for Half-Duplex Teletypewriter Lines," recommended by the AIEE Committee on Telegraph Systems, and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer and Pacific Meeting, San Francisco, Calif., June 25–29, 1956. Scheduled for publication in AIEE *Communication and Electronics*, 1956.

J. L. Maxwell and **H. K. Farrar** are with the Pacific Telephone and Telegraph Company, San Francisco, Calif.

Clinton R. Hanna 1955 Lamme Medalist

Dr. Hanna of the Westinghouse Laboratories, Pittsburgh, Pa., has been awarded the 1955 Lamme Medal " . . . for his fundamental calculations and developments in the field of electrodynamics and particularly for his achievements in the design of generator voltage regulators, automatic rolling mill controls, and tank gun stabilizers."

History of the Medal

J. J. PILLIOD
FELLOW AIEE

IT IS A PRIVILEGE to introduce the activities now before this meeting, which culminate in the presentation of the 1955 Lamme Medal to a distinguished member of the Institute, selected unanimously by the Lamme Medal Committee. This medal, carrying with it high recognition of achievement in the electrical field, is due to the vision of the late Benjamin Garver Lamme, chief engineer of the Westinghouse Electric Corporation.

Mr. Lamme was awarded the Edison Medal of the Institute in 1919. It seems clear that he had in mind the fact that "Man does not live by bread alone" and that the satisfaction which goes with recognition of outstanding achievement by qualified judges is an inspiration not only to the recipient but to many others. He made provision in his will for an award to members of the Institute who have "shown meritorious achievement in the development of electrical apparatus and machinery."

Thus was the Lamme Medal established in the proceedings of this Institute and this is the 28th Annual Award. It has served well in providing a means of special recognition to a distinguished group of men who have attained prominence in the "development of electrical apparatus and machinery" in the broad sense in which these words have come to be understood.

May that record continue and may continuing thought be given to the possibility of establishing still other awards that might further stimulate creative development of people working in the field of electrical science for the benefit of mankind.

Presentation and acceptance addresses given at the Lamme Medal ceremony held during the AIEE Summer and Pacific General Meeting, San Francisco, Calif., June 25–29, 1956.

J. J. Pilliod, American Telephone and Telegraph Company (retired), is chairman of the AIEE Lamme Medal Committee.

The Medalist

J. A. HUTCHESON
FELLOW AIEE

FAR TOO OFTEN, in the hustle and bustle of modern life, we fail to consider what lies behind the development of the many things we have, the things which collectively have provided this country with the highest standard of living in the world. As a result, the contributions made by engineers which result in a better life for all of us frequently receive no recognition. For this reason, among many others, I count it a privilege as well as an honor to be able to tell you something about the many contributions that have been made by one of these engineers which have benefited the lives of all of us here today.

In the mid 20's, a new phonograph was introduced which provided greatly improved reproduction of music. The frequency range of this instrument was expanded several octaves, resulting in an amazing improvement in the quality of the sound. I am sure there are many in this audience today who can remember that time and remember the thrill they experienced when they first listened to a record played on this new device. The application of the exponential horn was instrumental in improvements in the reproducing system. Probably few, if any, of you ever knew that the man we honor today was responsible in large measure for this development.

Clinton Richards Hanna was born on December 17, 1899, in Indianapolis, Ind. He received his early schooling in Indianapolis, then entered Purdue University, Lafayette, Ind., in 1918. While at Purdue, his technical ability received early recognition through his election to the national honorary fraternities of Tau Beta Pi, Eta Kappa Nu, and Sigma Xi. He received the degree of bachelor of science in electrical engineering from Purdue in 1922. Four years later, his university honored him with an

J. A. Hutcheson, Westinghouse Electric Corporation, is vice-president—engineering.

electrical engineering degree and again in 1945 he was given the honorary degree of doctor of engineering.

Following his graduation in 1922, he was employed by the Westinghouse Electric Corporation.

Upon completion of his first assignment on the graduate student training program, he joined the Westinghouse Research Laboratories and has been associated with the Laboratories since that time.

If I were asked to tell you in a word that which most characterizes Dr. Hanna, my answer would be versatility. The record which this man has built will show you why this is so.

His work on the exponential horn in the field of acoustics has already been mentioned. Perhaps it is not illogical to find him expanding his interest in the general field of sound reproduction next. Nevertheless, to switch from acoustics to electronic circuit theory is not an obviously easy step. However, Dr. Hanna took this step and in the next few years, devoted his time to the study and development of electrodynamic loud speakers. In connection with his work in this field, he found need for the use of transformers and reactors which not only had alternating voltages applied to them, but also had direct current flowing in their windings. Finding no literature on this subject, he undertook to study the phenomena which arose in the application of such devices. This work resulted in a paper describing the action of these circuit elements under the operating conditions experienced. This paper, the third he had published, appeared in print in 1927.

Today our engineering departments have groups of specialists, each working in his own particular field. At that time (still 1927), however, such specialists were not generally available. Realizing the need for a new type of vacuum tube to be applied to electronic sound reproducing systems, Dr. Hanna next undertook the development of the tube he needed. The result of this phase of his work was the *UX-250*, the first commercially successful power tube for use with loud speaking systems. The results of this work were published in a paper which appeared in 1928.

It was in 1928 that Dr. Hanna turned his talents in yet another direction. Many of you will remember the earliest talking movies in which the sound was recorded on phonograph records which in turn were synchronized, more or less, with the film. It was clear at the outset that the proper way of synchronizing sound with the action on the film was to put the sound on the film, and it was this that occupied his attention for the next few years. Out of his work in this field came a number of new ideas. One of the problems which plagued the earliest "sound on film" systems was caused by variations in the rate at which the sound track passed the pick-up head in the projector. The resultant sound varied in pitch, giving rise to unpleasant reactions on the part of the viewer-listener. Dr. Hanna devised a most effective simple solution to this problem using a double flywheel filter in the film drive mechanism. Another problem was that of background noise which was occasioned by dirt and scratches on the film and by the graininess of the film emulsion. This problem likewise was solved by Dr. Hanna through the use of a means for reducing the average amount of recording light when recording low intensity sound. These two ideas are used today in our present talking movies, both contributing largely to our enjoyment of this form of entertainment.

CLINTON RICHARDS HANNA (*center*) receiving the 1955 Lamme Medal Award from President M. D. Hooven (*right*) as J. A. Hutcheson (*left*) looks on.

By this time it should be clear that Dr. Hanna can be described accurately as a versatile engineer. But the degree of versatility which he possesses is still to be described. Consider now the next phase of his career. Beginning in the early 30's, he started work in the broad field of automatic control systems. He had a strong belief that the then typical methods of development of such systems, the cut-and-try methods of that era, were fated to become more and more impractical. Therefore, he set out to develop methods whereby it would be possible to calculate the performance of a proposed system in advance of its actual construction. As a result of his studies in this broad field, he succeeded in working out unique methods for performing the necessary calculations.

He applied his methods to a wide range of systems used for regulating voltage, current, speed, position, acceleration, and tension. In general, in all of this work, he was seeking to develop basic information relative to the broad field of automatic control systems. It was well that he did this, for as the development of his ideas was well advanced, our nation became involved in World War II. At this time, the need for the results of his work became acutely apparent. Fortunately, he was ready, and as a result, a large number of important developments were made in a remarkably short span of time.

The earliest of these developments was that of the stabilizer for the guns mounted in tanks. Prior to this

development, the Army's experience with their tanks showed they could expect a hit from about one per cent of the shots fired while the tank was in motion. Dr. Hanna's stabilizer improved this situation to the point that hits were attained with seventy per cent of the shots.

Another of the developments of this period was that of a tracer controlled machine tool. Applying the principles he had developed, Dr. Hanna was able to develop this precision control device so that both sides of a propeller blade twenty-four feet in diameter could be machined automatically with a maximum error of one-hundredth of an inch.

Yet another automatic control system was developed and applied to the stabilization of radar antennas mounted on naval vessels. This device was so accurate that, although the ship might roll up to forty-five degrees on either side of the vertical, the antenna position could be maintained to less than a tenth of a degree.

Time does not permit even brief descriptions of the many other developments he achieved during the war. Suffice it merely to mention among them the development of a voltage regulator for the electrical system of bombers, an electric traverse drive for tank turrets, an electric drive for 16-inch harbor defense guns, and an aircraft turret stabilizer.

The value of his contributions was recognized early in the war. In 1942, President F. D. Roosevelt presented him with a citation from the War Production Board for "meritorious contribution to the war production drive."

Since the end of World War II, Dr. Hanna has continued to apply his talents to the solution of many peacetime problems. Among these many recent developments are the improved automatic controls for steel mills, an automatic pilot for use on high speed jet aircraft, a gyroscopic speed control for elevators, and a rail car stabilizer which has greatly improved the riding qualities of railroad cars.

Any statement purporting to set forth Dr. Hanna's abilities would not be complete without a reference to his ability to attract and train high quality men. Too often, we see in the highly capable engineer a man who, because of his preoccupation with his own technical interest, is one who is the lone wolf, the individualist, the one who passes little or none of his knowledge on to his fellow worker. This, however, is not Dr. Hanna. Rather, he is one who enjoys and welcomes the opportunity to work with other men and to pass on to them the knowledge he has acquired through his own personal efforts.

At the outset, I stated that the one most distinguishing characteristic of this man was his versatility. In telling you briefly about his contributions to acoustics, to vacuum tubes, to talking movies, to gun stabilizers, and to automatic pilots, among others, I am sure I have convinced you that this engineer is indeed a versatile man. Likewise, I am sure that you now appreciate why the Lamme Medal which, under the terms established by Mr. Lamme was to be given "to a member of AIEE who has shown meritorious achievement in the development of electrical apparatus or machinery" is so richly deserved by the man we honor here today, Clinton Richards Hanna.

Achievements of Co-operation

C. R. HANNA
FELLOW AIEE

I AM DEEPLY GRATEFUL for the high honor accorded me by the Institute in the award of the Benjamin Garver Lamme Medal. My colleagues also share in this because without their ideas and effort much of the progress for which the citation was made would not have come to fruition.

I am especially appreciative of this award because it was my good fortune to have been assigned to one of the last classes in engineering training personally supervised by Mr. Lamme. His simple, direct approach to the heart of any problem was an inspiration to me and to any other young engineer who had the opportunity to come into contact with him.

As I reflect on the past 35 years, I cannot help but observe that my efforts have been characterized by a continual decrease in frequency. I hasten to add for the ears of my employer that this is not an admission that there has been a slowing down of performance, but rather that the physical phenomena with which I have been concerned have had lower and lower frequency.

While an undergraduate, my chief interest was in the rapidly developing field of radio which I hoped to enter upon graduation. You can imagine my surprise when I learned that my first assignment after joining Westinghouse Research Laboratories was to be in the audio field. This was quite a drop from the high frequencies of radio. After an interesting period in the development of means for reproducing sound and later for recording sound, I was subjected to another step toward low frequency.

Sound motion picture apparatus required the development of passive mechanical filters for insuring nearly perfectly constant velocity of film past the point of recording or reproduction. Such filters attenuate all frequencies above a fraction of a cycle per second. Regulators and stabilizers likewise are filters because they minimize the deviations of a regulated quantity in the presence of disturbing influences. They are active rather than passive filters, however, inasmuch as energy sources are involved. Regulators and stabilizers embrace the frequency range from 10 cps down to perhaps 1/20 cps. I was getting farther and farther from my first love, radio. But regulators it was.

The present award of the Lamme Medal is based partly upon automatic control developments. I should like therefore to recall the state of the regulator art 25 years ago. It was truly an art because no one had made any adequate attempt at the mathematical analysis of systems. The concept of impedance was slowly being adapted to the study of vibratory mechanical systems with the same tremendous advantage that it had had for electrical systems. Electrical analogues for mechanical and electromechanical systems also were being used. But there were no computers

C. R. Hanna, Westinghouse Electric Corporation, is associate director of the Westinghouse Research Laboratories.

available unless the slide rule and the adding machine be called computers. Workers in the regulator art who wanted to be scientific had to sweat out the solution of the higher order differential equations involved to determine the stability and damping of their new systems. Such handicaps had their compensations, however. Short cuts were devised to permit rapid extraction of complex roots of equations even up to the ninth degree. Also, in order not to solve so many equations in the determination of a good system, we were forced to develop a better judgment in our choice of parameters, and we soon learned what would work, what would not, and how much to use.

There were other missing tools 25 years ago. Among these were needed components such as measuring means for the various quantities to be regulated; new forms of amplifiers like the Silverstat, the two-stage Rototrol, the magnet controlled hydraulic valve; and antihunting means like the rate gyroscope and the properly designed feedback transformer. Also, much information pertinent to regulators was lacking on existing machines such as generators and motors. It all seems so easy now, but not in the early 30's.

As progress was made, it appeared desirable to enter the gyro field to obtain space regulation of systems. Gyros are generally used to measure absolute angular position and absolute angular velocity. Those of the first type may have periods ranging from minutes up to hours. Some of them are concerned with earth's rotation which is one revolution per day. Here was a further big step downward in frequency! In an effort to understand the antics of the gyroscope, I very early made a study considering it as a mechanical transformer with an input axis at right angles to the spin axis and an output axis at right angles to both spin and input axes. The coupling through the spinning inertia permits the transfer of mechanical energy from one axis to the other. The gyro itself is an entirely passive device inasmuch as no spin energy is available at either the input or the output axis. The study disclosed the little known fact that a mechanical impedance imposed upon the output axis manifests itself at the input axis in reciprocal fashion. Thus, an inertia at the output axis shows as a torsional stiffness at the input axis, while a torsion spring at the output axis is felt as an inertia at the input axis. A low impedance at the output axis shows as a high impedance at the input axis and vice versa. Using this very simple relation such phenomena as gyro nutation or high frequency oscillation are readily explained and minimized. Also through its use, the various forms of restrained gyro such as the rate and integrating gyros employed today can be designed in a straightforward manner.

The contribution to the gyro stabilizer field, I believe, has been in the widespread application of the rate gyro. This type of instrument has the merit that it is always locked to the stabilized body and, therefore, cannot tumble as do unrestrained or free gyros. By itself, it can regulate only zero or finite angular velocity. It may, however, be supplemented by a directional influence such as gravity, magnetic heading, rate of climb as in aircraft, etc., to regulate angular position. Principal applications of gyros have been in the stabilization of guns, radar antennas, and aircraft; and as antihunting means for angular position regulators, all of which have been manufactured in large quantities.

In retrospect, these pursuits into the low frequency field of electrodynamics have all been most interesting and, I believe, just as fascinating as radio. The fact is that all new fields of engineering or science are challenging. And what is more stimulating in life than a challenge?

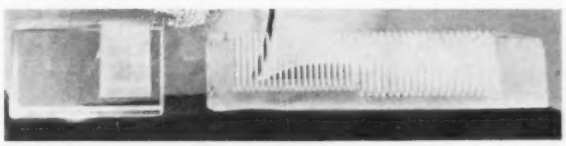
Again for myself and my associates, I thank you for your kind appraisal of our work and for your generosity in the award of the Lamme Medal.

Previous Award Winners

1928 Allan Bertram Field	1941 Forrest E. Ricketts
1929 Rudolf E. Hellmund	1942 Joseph Slepian
1930 William J. Foster	1943 A. H. Kehoe
1931 Giuseppe Faccioli	1944 S. H. Mortensen
1932 Edward Weston	1945 David C. Prince
1933 Lewis B. Stillwell	1946 J. B. MacNeill
1934 Henry E. Warren	1947 A. M. MacCutcheon
1935 Vannevar Bush	1948 V. K. Zworykin
1936 Frank Conrad	1949 C. M. Laffoon
1937 Robert E. Doherty	1950 Donald I. Bohn
1938 Marion A. Savage	1951 Arthur E. Silver
1939 Norman W. Storer	1952 I. F. Kinnard
1940 Comfort A. Adams	1953 F. A. Cowan

1954 Aldo M. deBellis

Paper Thin Quartz Wafers



U. S. Army Photograph

Army scientists now cut paper-thin wafers of quartz with a "sound slicer" that never touches it.

Quartz wafers, or crystals, are vital for radar, guided missiles, and radio communications. With the ultrasonic slicing technique, engineers at Fort Monmouth's Signal Corps Engineering Laboratories get three times as many usable crystals from a block of the mineral than with the best diamond saw.

The new slicer simultaneously cuts 21 delicate slabs from a chunk of mineral as if it were a tiny crystalline loaf of bread. The sound slicer will stretch the U. S. stockpile.

The cutter's bit resembles a closely stacked pack of razor blades and vibrates like a pneumatic hammer, but 25,000 times a second. The bit itself does not touch the quartz while cutting; it comes microscopically close. Boron carbide flows between slicer and quartz. As the tool vibrates, boron particles rapidly nick out tiny flakes of quartz.

The diamond saw, used for over 20 years, slices only 750 units from 12 pounds of crystal. The ultrasonic cutter slices 2,250. Sound-sliced wafers are 12 mils, whereas the thinnest diamond saw cut one is 33 mils. Wafers are ground and polished to specified thickness, depending on use.

A Valve-Controlled Hydraulic Servomechanism

D. V. STALLARD
ASSOCIATE MEMBER

HYDRAULIC SERVOMECHANISMS with flow-control valves are applied in many systems that require high performance, light weight, and power output of several horsepower. Unfortunately, hydraulic servos are not widely understood, for there is very little relevant textbook material and only a few technical papers.[1] This investigation extends the now existing work by presenting an analysis of a complete hydraulic servo, together with experimental results that verify the analysis. The servo (Fig. 1) has an amplifier, a single-stage flow-control valve, a single-vane rotary motor with inertia load, and a position feedback.

The valve operates from a source of constant oil pressure and has four orifices, which are all varied simultaneously in stroke X by the spring-restrained electromagnetic torque motor. A steady current I into the torque motor causes a proportional valve stroke, motor flow-rate, and motor velocity in the direction determined by the current.

An important analytical result is that the transfer function X/I from torque-motor current I to valve stroke X can be separated from the transfer function relating stroke and load velocity. The reason is that the effect of static flow forces on an uncompensated valve piston is equivalent to that of an extra centering spring; the motor operation does not affect the valve stroke appreciably.

The dynamic response of the servomotor and load for a varying valve stroke is analyzed with two basic equations: the equation of continuity for the mass flow-rate of oil leaving the valve, and Newton's second law for the inertia load.

The resulting differential equation relating the load velocity to valve stroke X is linear with constant coefficients. It is transformed and manipulated to form the transfer function relating load velocity $s\theta$ to valve stroke X, thus

$$\frac{s\theta}{X} = \frac{k_x/D_r}{1+2\zeta\left(\frac{s}{\omega_n}\right)+\left(\frac{s}{\omega_n}\right)^2}$$

The frequency response of load velocity for a sinusoidally varying valve stroke has constant amplitude at low frequencies, peaks near the resonant frequency ω_n, and falls off rapidly at higher frequencies. The height of the resonant peak depends on the damping ratio ζ.

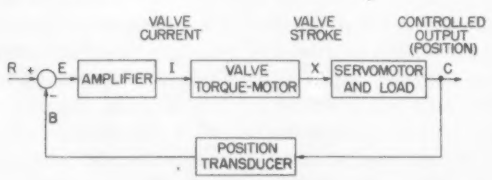


Fig. 1. Elementary valve-controlled hydraulic servo.

The motor resonance tends to make the servo unstable. Physically, this resonance is an interchange of energy between inertia and compliances. The resonant frequency ω_n depends on the load inertia and on certain compliance parameters, i.e., the mechanical, line, and oil compliances, as defined.

The other previous articles have completely neglected the mechanical compliance, which results from the finite elastance of the metal parts and tends to be surprisingly large. Line compliance results from elastance of the lines from valve to motor. Oil compliance results from the finite oil compressibility; it varies inversely with radian displacement and is generally irreducible in a given motor with short lines. The damping ratio depends mainly on leakage past the motor vane and, to some extent, on friction and valve leakage.

One very useful analytical supplement is the equivalent mechanical network, relating load velocity to valve stroke. It is a single loop with a velocity source, two damping parameters, four compliances, and the load inertia in series. The electrical analogue is a voltage generator in series with resistances, inductances, and a load capacitance.

From the basic theory of the valve, motor, and load, expressions are derived for the velocity constant and torque constant of the hydraulic servo.

The experimental system included a fast single-stage valve operating at 1,000 pounds per square inch and a single-vane servomotor, which was directly connected to an inertia load. An unusually good agreement between measured and calculated values of motor resonant frequency resulted from taking into account the mechanical compliance, which was four times the oil compliance. Theory and experiment agreed well for damping ratio, phase margin, and torque constant.

An improved hydraulic motor has recently been developed, with less than half the weight and radian displacement of the original motor. Because the new motor is mechanically stiffer, it has a slightly higher resonant frequency than the original motor with the same inertia load, despite the inevitable increase in oil compliance.

This theory has proved to be very useful for analysis, evaluation, and design, and it has given insight into the dynamic operation of many other types of valves, motors, and systems.

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D. V. Stallard is with Massachusetts Institute of Technology, Cambridge, Mass.

A High-Power Cathode Circuit Breaker

L. D. McCONNELL
ASSOCIATE MEMBER AIEE

J. D. FINDLEY
ASSOCIATE MEMBER AIEE

RECENT INCREASES in the size of d-c systems fed by mercury-arc rectifiers have created a need for a faster, higher capacity cathode circuit breaker. These high power d-c systems have many rectifiers in parallel and are subject to a fault condition peculiar to mercury-arc rectifiers, known as arc back. If there were no protective device in the circuit, these arc-back currents would ultimately reach a size much beyond that which might be tolerated. Mechanical stresses and overheating would damage the equipment.

A cathode breaker used for arc-back protection must, therefore, be fast enough to limit the current to a tolerable value. The safe and continuous operation of these large and concentrated d-c systems depends upon the removal of the d-c short circuit by the breaker. Hence, the breaker must be reliable.

To meet the needs just described, a new breaker has been developed (Fig. 1). Since rectifier-unit ratings are increasing, the rating of this new breaker was set at 1,200 volts and 10,000 amperes continuously. In a rectifier system in which arc-back cathode current might rise to 100,000 amperes in 0.008 seconds if no breaker were in the circuit, this new breaker is rated to limit the current to 75,000 amperes. Interruption of such a fault will be completed within one cycle.

For this new breaker, the "magnetic de-ion" interrupter principle was chosen, wherein the arc is forced magnetically upward into the inverted "V" slots in a series of spaced zircon porcelain plates. The arc chute size and configuration were chosen by comparative study of d-c tests on various existing interrupters with particular attention to arc voltage, power, and energy. The shape of the series air-core blowout coil was co-ordinated with the arc chute and arc horns to give maximum speed of upward arc motion.

In the design of the contact structure, emphasis was placed on durability and earliest possible contact separation. To obtain early contact separation, the necessary contact resilience is located in the stationary main and moving arcing contacts. The design gives main-contact parting coincident with start of motion in the moving contact. Thus, the amount of arcing-contact follow needed to assure full protection of the main contacts from arc damage is reduced and earlier separation is achieved. The arcing contacts are tungsten alloy and are generously proportioned to give long life and minimize need for adjustment.

Over 300 interrupting tests were made in the laboratory to prove the breaker's performance. First, on a 750-volt d-c circuit with an ultimate short-circuit current of 80,000 amperes and an inductance of 70 microhenrys, the breaker easily limited the current to 35,000 amperes in 0.0065 seconds. Next, on a 1,500-volt d-c circuit with an ultimate short-circuit current of 40,000 amperes and an inductance of 280 microhenrys, the breaker limited the current to 24,000 amperes in 0.0075 second. The breaker completed the interruption in 0.011 seconds.

To obtain laboratory test power beyond the limits of any available d-c facilities, a-c high power equipment was used at 12 and 25 cycles. Synchronous timing equipment initiated the short circuit at a desired instant in the low frequency wave. In a typical test, the breaker limited a current rising at 12.4 amperes per microsecond to 77,000 amperes at 0.0075 second. Interruption was complete at 0.012 second. At the limitation instant, arc voltage was 1,000 volts; later it rose to 3,000 volts. Maximum arc power was about 130 megawatts, and total arc energy 500 kilowatt-seconds. This unusually large power test of a direct current interrupter gives assurance that the breaker will meet the rating stated above. Over 150 high-power tests were made on one pair of arcing contacts and their useful life was only partially exhausted. Thus, the very essential characteristic of durability was demonstrated.

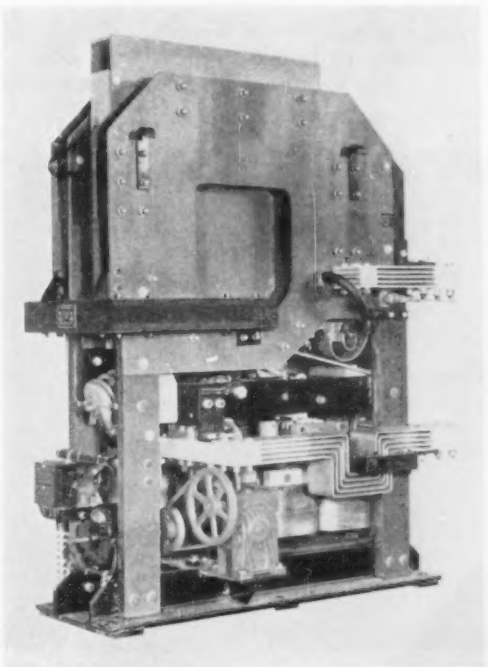

Fig. 1. Side view of breaker with arc chute in closed position.

Digest of paper 56-185, "A New High-Power Cathode Circuit Breaker," recommended by the AIEE Committee on Industrial Power Rectifiers and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 30–February 3, 1956. Scheduled for publication in AIEE *Applications and Industry*, 1956.

L. D. McConnell is with Canadian Westinghouse Company, Ltd., Hamilton, Ont., Canada; **J. D. Findley** is with Westinghouse Electric Corporation, East Pittsburgh, Pa.

Gas-Blast Switch Tests on 230-Kv System

P. E. RICHARDSON
ASSOCIATE MEMBER AIEE

AREM FOTI
ASSOCIATE MEMBER AIEE

Performance of a gas-blast switch on a 230-kv system of the U. S. Bureau of Reclamation near Hoover Dam is reported in this article. This switch has proved to be an economical means of interrupting transformer magnetizing current, parallel load current, and line charging current.

IN RECENT YEARS, considerable work has been done by manufacturers and users of power switching equipment in a combined effort to establish the interrupting capability of outdoor air switches.[1] Various types of interrupting attachments have been devised and applied to air switches in an effort to improve their interrupting ability. A gas-blast switch employs a high-velocity jet of gas to extinguish the electric arcs. Tests were conducted on a manually operated gas-blast switch on a 230-kv system of the U. S. Bureau of Reclamation near Hoover Dam. The tests included the interruption of transformer magnetizing, parallel load, and line charging currents. The switch also was closed on these loads. Loadings of up to 112.5 mva of transformer capacity, 80 mva of parallel load, and 84 miles of line were switched successfully, and oscillograms were obtained of the tests.

Until the time of the tests reported in this article, only very limited data were available for gas-blast switches in ratings above 161 kv.[2] To the best of the authors' knowledge, the only data for gas-blast switches on 230-kv systems concerned the results of tests in which a gas-blast switch was used to energize and de-energize a 230-kv series capacitor bank. Therefore, it is the purpose here to report the performance of a 230-kv gas-blast switch, when used to interrupt transformer magnetizing current, parallel load current, and line charging current. System conditions did not permit interruption of regular load currents.

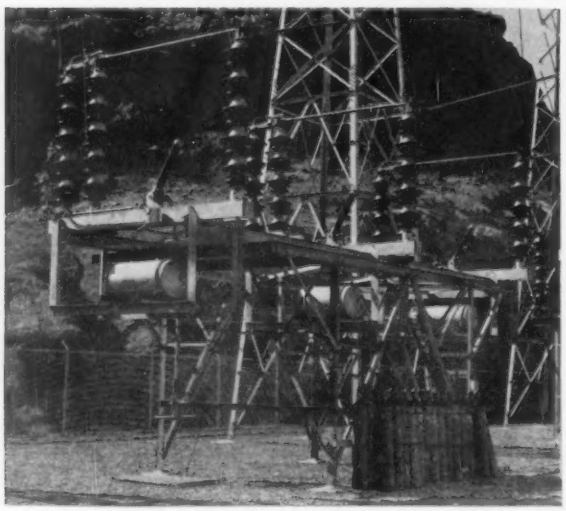

Fig. 1. Gas-blast switch installation at Hoover Powerplant Substation. Note receiver tanks under each phase. Twelve bottles of nitrogen were used during test program.

DESCRIPTION OF TEST SWITCH

General Arrangement. The switch was tested to determine its performance under actual service conditions. Although the transformer magnetizing current interruption tests were conducted at a site different from that for the parallel load and line charging current tests, the switch installation was identical at both locations except for a difference in height of switch mounting structure. Interruption tests of transformer magnetizing current were conducted at the Basic Magnesium Substation of the Parker-Davis Project near Henderson, Nev., and the balance of the testing was done at Hoover Powerplant, Arizona–Nevada (230-kv) Switchyard, at the Hoover Dam Boulder Canyon Project. Lines dropped were on the Parker-Davis Project.

Fig. 1 shows the switch installation at the Hoover Powerplant Substation. The switch is a 3-pole unit, rated 1,200 amperes, 230-kv nominal voltage, with a 900-kv basic impulse insulation level. It is of the conventional 3-insulator vertical-break type, group-operated by a manually operated handwheel located near ground elevation. The switch was mounted on a 12-foot high rack, as shown. The height of the switch rack at Basic Magnesium Substation was 26 feet.

Gas-Blast Interrupting Attachment. The gas-blast interrupting attachment is mounted on a standard air switch. As seen in Fig. 1, each switch pole unit is equipped with a porcelain tube mounted between the blade insulator stacks, and each porcelain tube has a convergent-divergent

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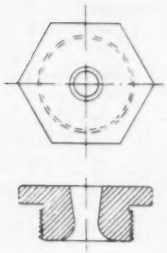
P. E. Richardson is with the Bureau of Reclamation, U. S. Department of Interior, Denver, Colo.; **Arem Foti** is with I-T-E Circuit Breaker Company, Greensburg, Pa.

The authors wish to acknowledge the co-operation and assistance of the offices of the U. S. Bureau of Reclamation and other agencies and utilities in making the test program possible. The U. S. Bureau of Reclamation offices include the branch of Design and Construction at Denver, Colo.; Region 3, Boulder City, Nev.; the Boulder Canyon Project, Boulder City, Nev.; and the Parker-Davis Project, Phoenix, Ariz. Other utilities and agencies include the City of Los Angeles, Department of Water and Power; and the Colorado River Commission of Nevada. We also wish to acknowledge the helpfulness of data received from electric utility companies concerning the application of gas-blast switches in other voltage ratings, particularly the Kansas City Power and Light Company for data concerning quite extensive tests conducted on their 161-kv system.



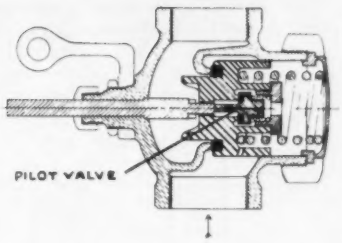


Fig. 2 (left). Nozzle for gas-blast switch. Fig. 3 (right). Quick-opening self-closing valve.

nozzle (Fig. 2), aimed to deliver the high-velocity jet of gas into the arc stream. Each porcelain tube is connected to a receiver tank, which is mounted under the single-pole switch unit. The three receiver tanks are, in turn, connected with a supply pipe line by which the tanks are charged to proper pressure before the switch is operated. Either nitrogen or compressed air may be used to charge the receiver tanks. For the tests being reported, bottled nitrogen was used.

Between each porcelain tube and each receiver tank is a quick-opening self-closing valve (Fig. 3) actuated by the switch-operating mechanism. In this manner, the valve is opened to release the jet of gas just prior to separation of the arcing horns and remains open for approximately half of the opening travel of the blade.

Fig. 4 shows the mechanism which actuates the blast valves in response to motion of the switch rotating insulators. The cam (Fig. 4) holds the valve open against the pressure of the valve reset spring and once the cam disengages the valve lever assembly, the reset spring returns the valve to its closed position.

Employment of the valve-actuating lever assembly (Fig. 4) results in gas blast for the switch-opening operation only. With minor modifications in this lever assembly (Fig. 5), gas blast may be supplied for both opening and closing operations. However, during the entire test program being reported, the gas blast was used to extinguish the arc on switch-opening operations only, and very little display was observed during closing operations.

The design and location of the porcelain tube between the blade insulator columns presented a dielectric problem. To determine the positioning of the porcelain tube and its support, so as not to lower the impulse level of the switch, tests were made at the R and IE Laboratory at I-T-E Company. A 230-kv switch was simulated by assembling a section of 2-inch IPS (iron pipe size) conductor across two insulator columns, spaced 8-feet apart, as pictured in Fig. 6. The location of the porcelain tube was variable along the base which supported the two insulator columns, and critical impulse flashover voltages were obtained for the various positions. At no time were any flashovers observed to the nozzle, which is located at the upper extremity of the porcelain tube. The impulse tests defined a permissible region in which the porcelain tube support could be placed without influencing the impulse characteristics of the switch. Accordingly, the porcelain tube assembly was located on the tested gas-blast switch within this permissible area.

DESCRIPTION OF TEST CIRCUITS

For the interruption of transformer magnetizing current at the Basic Magnesium Substation, a test circuit was arranged to connect the primary side of an unloaded 75,000-kva 230- to 13.8-kv transformer to the system through the test switch. Since system conditions did not permit paralleling another bank to obtain tests at heavier loading, an unloaded bank of 37,500-kva 13.8- to 69-kv transformers was connected to the secondary of the first bank to provide for interrupting the magnetizing current of 112,500 kva of transformer capacity. A switching diagram of this circuit appears in Fig. 7. Oscillographic records were obtained of the following quantities: (1) line-to-ground voltage in three phases, line side of test switch; (2) voltage across test switch in one phase; (3) line-to-ground voltage in one phase, load side of test switch; (4) current through test switch in three phases; (5) voltages across one phase of transformer secondary, 13.8 kv; and

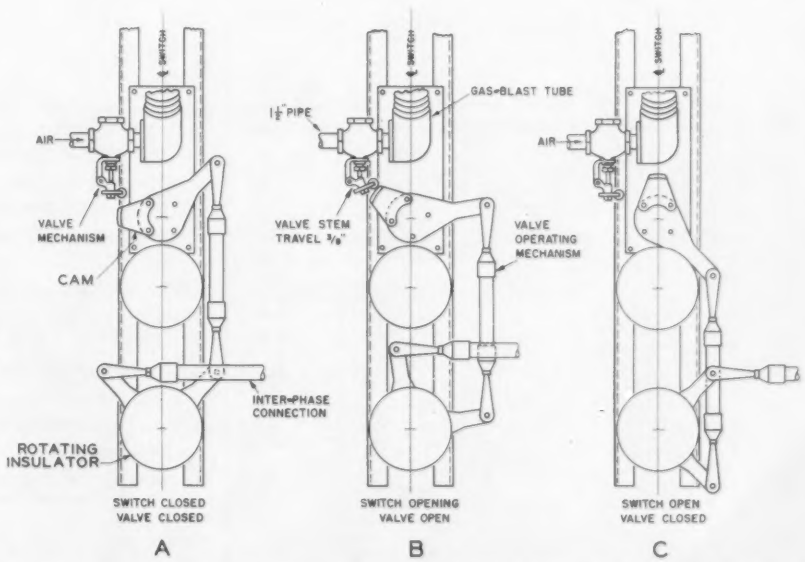


Fig. 4(A). Valve-actuating lever assembly with switch in closed position and valve closed. (B). Lever assembly with switch partially open prior to separation of arcing horns. (C). Lever assembly with switch in open position.

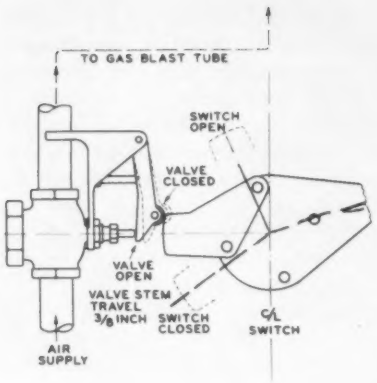
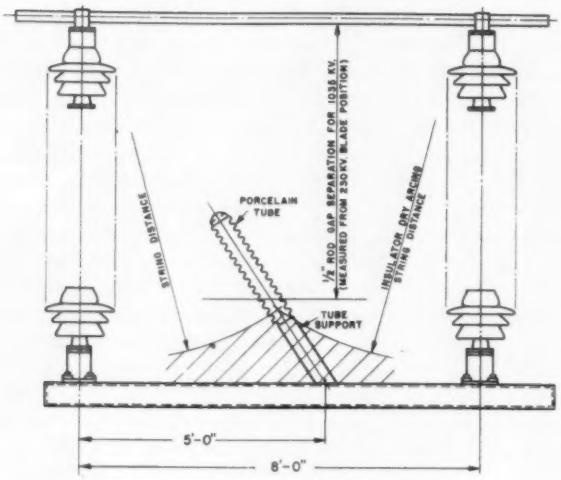


Fig. 5 (left). Valve-actuating lever assembly for supplying gas blast for both switch opening and closing operations.



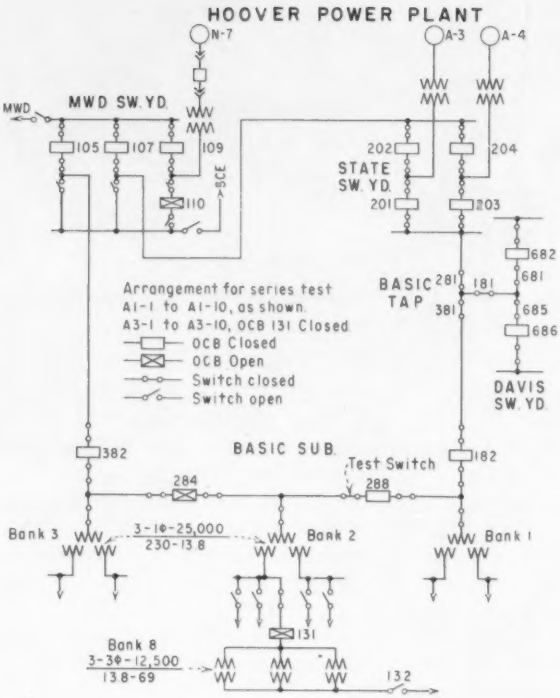


Fig. 6 (left). Arrangement for impulse tests to determine location of porcelain tube support. Fig. 7 (above). Single-line diagram for transformer magnetizing current tests.

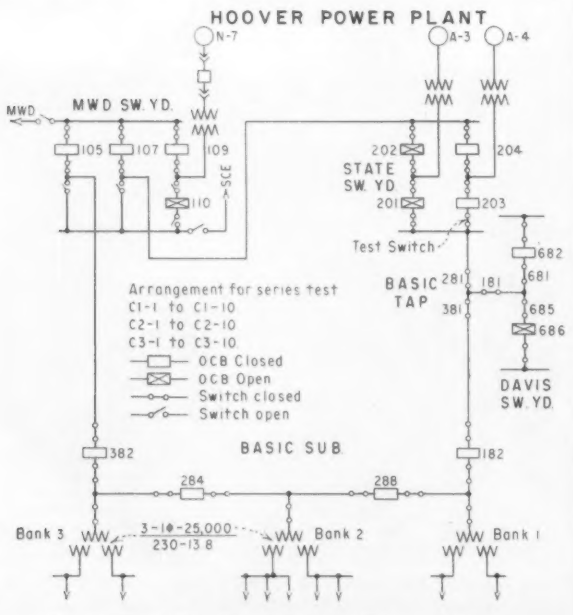


Fig. 8. Single-line diagram for parallel current tests.

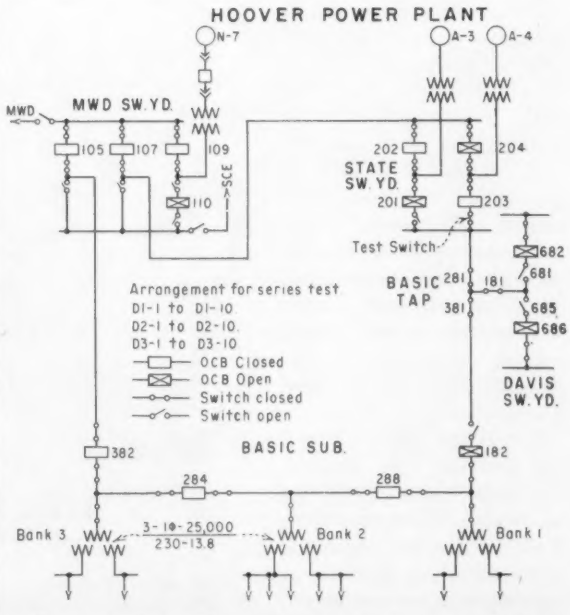


Fig. 9. Single-line diagram for line charging current tests.

Table I. Interrupting Transformer Magnetizing Current 230-Kv Gas-Blast Switch, Installed at Basic Magnesium Substation, April 12, 1955

Test Number	Description	Average Gas Pressure, Psi		Remarks
		Start	Finish	
A1-1 through A1-10	Energizing and de-energizing transformer bank #2, single-line diagram, Fig. 7. (75,000-kva bank)	138	98	All successful opening operations with approximately 12-inch arc length. Very little display on closing operations.
A3-1 through A3-10	Energizing and de-energizing transformer banks #2 and #8, single-line diagram, Fig. 7. (112,500-kva bank)	130	95	All successful opening operations with approximately 15-inch arc length. Insignificant display on closing operations.

NOTES: Recording and indicating ammeters were not sensitive enough to obtain readings. The recording voltmeter showed a constant voltage of 61 volts, equal to 122,000 volts phase-to-ground and 211,000 volts phase-to-phase on the line side of switch throughout the tests.

The transformer manufacturer's test report, dated January 1, 1943, shows an average exciting current of 2.96 amperes at 100-per-cent voltage for 10 of these transformers supplied at Basic Magnesium Substation.

Gas pressure at start of opening operations for A1-series tests was from 140 to 135 psi; for A2-series starting pressure varied from 140 to 120 psi.

Table II. Tests Breaking 230-Kv Loop with Manually Operated Gas-Blast Switch, Hoover Dam, October 24, 1955

Test Number	Description	Average Gas Pressure, Psi		Remarks
		Start	Finish	
C1-1 through C1-7C	Parallel-load switching with 20-mva load flowing through switch, single-line diagram, Fig. 8.	107	82	All circuit interruptions successful with only a few inches arc length. Practically no display on closing operations.
C2-1 through C2-12	Same as C1-series except with 40-mva load.	96	76	All circuit interruptions successful with approximately 12-inch arc length. Practically no display on closing.
C3-1 through C3-12	Same as C1-series except with 60-mva load.	101	83	All circuit interruptions successful. Power factor is 95 per cent and 15-inch arc length. Practically no display on closing operations.
C4-1 through C4-2C	Same as C1-series except with 80-mva load.	150	120	All interruptions successful with 15- to 18-inch arc length. Current interrupted approximately 230 amperes. Practically no display on closing.

NOTES: Gas pressure at start of opening operations for C1-series tests was varied from 150 to 60 psi. The same was true for the C2-series of tests.
Gas pressure at start of opening operations for C3-series was varied from 150 to 95 psi. Pressure was not varied for the C4-series of tests.

(6) indication of time during which gas-blast valve was open.

A switching diagram of the circuit used for the interruption of parallel load currents at the Arizona–Nevada Switchyard is shown in Fig. 8. The distances around the parallel loop of 230-kv lines, as used in interruption of line charging current tests, are: Hoover Powerplant to Basic Tap is 4 miles; Basic Tap to Basic Substation is 16 miles; Basic Substation to Hoover Powerplant is 16 miles; and Basic Tap to Davis Powerplant is 64 miles.

Various loadings of the test switch were obtained by shifting load between Hoover and Davis Powerplants. During this series of tests, oscillographic records were obtained of the following quantities: (1) line-to-ground voltages in three phases, line side of test switch; (2) line-to-ground voltages in two phases, load side of test switch; (3) voltage across test switch in two phases; (4) current through test switch in three phases; and (5) indication of time during which gas-blast valve was open.

The circuit used for the interruption of line charging current tests is shown in Fig. 9. The various lengths of unloaded line connected to the source of generation through the test switch were obtained by suitable positions of disconnecting switches Nos. 181 and 381 at the Basic Tap.

For the line dropping tests, oscillographic records of the same quantities, as listed in the foregoing for the interruption of parallel loads, were obtained.

In all of the series of tests, except for the initial circuit setup for each change of conditions, the test switch was used to close in on the load as well as to interrupt it. Oscillographic records were obtained for all circuit interruptions and for at least one closure in each type and amount of loading.

TEST RESULTS

NUMEROUS SWITCH OPERATIONS were performed for circuit interruption under the various test-circuit arrangements described. At no time during the test program did any unsuccessful operation occur. During each opening and closing operation, the switch was operated, through the mechanism shown in Fig. 1, by a single operator. Results of the transformer magnetizing current tests are given in Table I, those for the parallel-load current tests are indicated in Table II, and those for the line charging current tests are tabulated in Table III. Following the tests, the switch was carefully inspected preparatory to its permanent installation at the Basic Tap Substation. It was found that there was some pitting and burning on the arcing horns and tips. This was of a minor nature and not considered serious enough to require any filing or dressing of the tips before installation. This indicates that the gas blast extinguishes the arc before any serious burning can occur.

Table III. Tests Interrupting 230-Kv Line Charging Current With Manually Operated Gas-Blast Switch, Hoover Dam, October 25, 1955

Test Number	Description	Average Gas Pressure, Psi		Remarks
		Start	Finish	
D1-1 through D1-10A	Interrupting charging current 20 miles of 230-kv line, single-line diagram, Fig. 9.	123	92	All successful operations. Arc length is 20 to 24 inches. Arc reach on closing operations is approximately 15 inches.
D2-1 through D2-10A	Interrupting charging current 68 miles of 230-kv line.	143	106	All operations successful. Arc length is 30 to 36 inches. Arc reach on closing operations is approximately 15 inches.
D3-1 through D3-10A	Interrupting charging current 84 miles of 230-kv line.	150	112	All operations successful. Arc length is 36 inches to 42 inches. Arc reach on closing operations is 15 to 18 inches.
D3-11 through D3-17C	Interrupting charging current 84 miles of 230-kv line to study effect of reduced gas pressures.	127	94	All operations successful. Arc length is 42 inches with starting pressure of 135 psi. Arc length is approximately 48 inches with starting pressure of 120 psi.

NOTES: For D1-series of tests, starting gas pressure was varied from 150 to 100 psi.
For D2-series, starting pressure was varied from 150 to 140 psi.
For D3-series, 150-psi gas pressure was used at start of all operations, except for D3-11 to D3-17C, for which tests the starting pressure was varied from 135 to 120 psi.

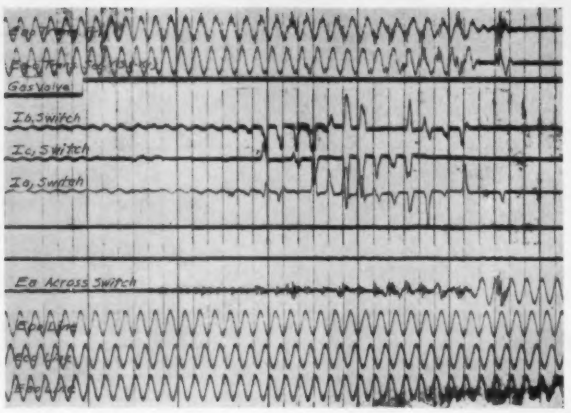


Fig. 10. Oscillogram #A1-6, interrupting transformer magnetizing current, 75,000 kva.

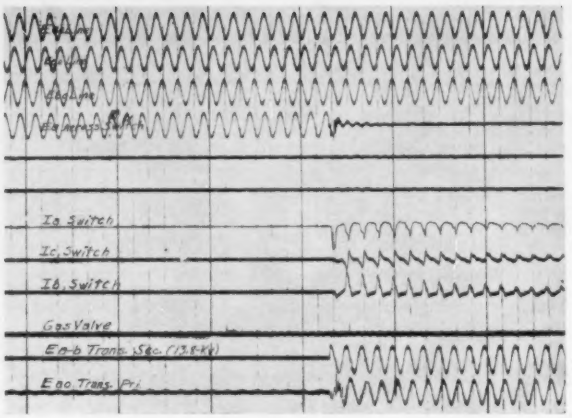


Fig. 11. Oscillogram #A3-2A, closing on transformer inrush current, 112,500 kva.

Reproductions of typical oscillograms appear as Figs. 10, 11, 12, 13, 14, and 15. Fig. 10 is typical of the interruption of transformer magnetizing current. With normal manual operation of the switch, about 27 cycles were required from parting of the arcing horns until the arc was extinguished. For about the last half of the arc duration, the current traces exhibit restrikes having magnetizing inrush current characteristics. It is to be noted that the voltage across the switch remains comparatively low until near arc extinction and contains high-frequency surges, as do transformer primary and secondary voltages. These are more in evidence in the primary than in the secondary voltage traces. The switching surges were about 133 per cent of normal in the primary and very little above normal in the secondary.

Fig. 11 is typical of closing the switch on unloaded transformers and exhibits typical transformer magnetizing inrush current with high harmonic content. Arcing was of considerably shorter duration in closing, continuing only until the arcing horns engaged.

Fig. 12 is a typical oscillogram of opening a parallel circuit and illustrates the ease with which the switch handled this type of interruption. On this and following oscillograms, the traces for voltage across the test switch show residual amounts with the switch closed because of mismatch of potential device ratios.

Fig. 13 is a typical oscillogram of a closure of the test switch on a parallel loop. No prestriking is noted and all three phases closed practically simultaneously.

Fig. 14 is for interruption of line charging current of 84 miles of 230-kv line. There were about 45 cycles of arcing with numerous restrikes, as is to be expected in dropping a line with a manually operated air switch. Voltage surges on the switch end of the line are in the neighborhood of $1^1/_2$ times normal. Voltage surges on the supply side of the switch approach twice normal, and those across the test switch $2^1/_2$ times normal. No system distress was observed as a result of these overvoltages.

Fig. 15 is an oscillogram of closing the test switch to charge 84 miles of line. The short arc duration is to be

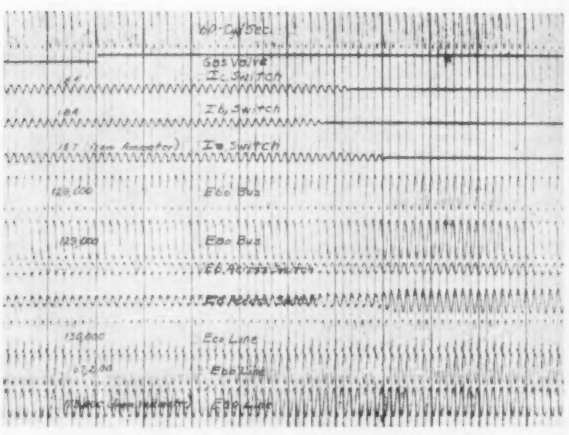


Fig. 12. Oscillogram #C3-5, interrupting parallel loop, 60 mva.

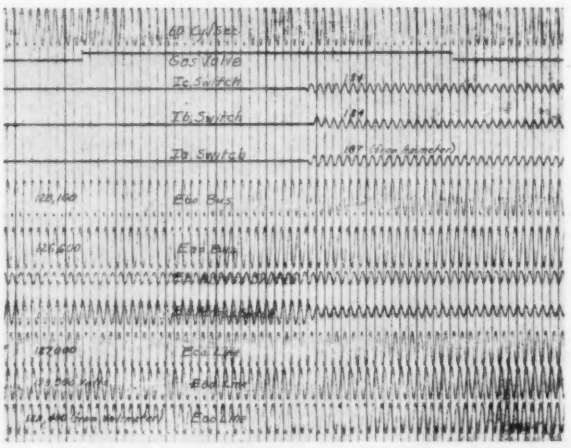


Fig. 13. Oscillogram #C3-1C, closing parallel loop, 60 mva.

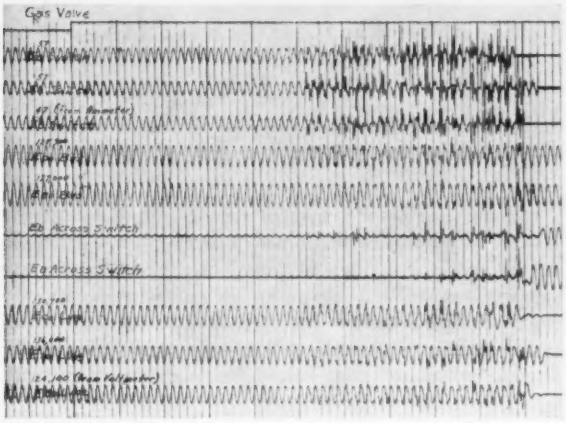


Fig. 14. Oscillogram #D3-5, interrupting charging current, 84 miles, 230-kv line.

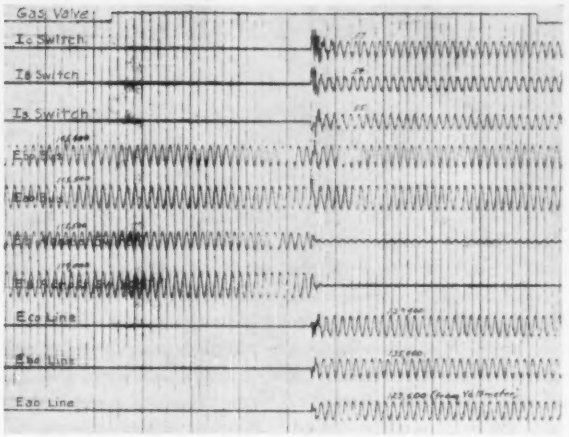


Fig. 15. Oscillogram #D3-1C, closing test switch to charge, 84 miles, 230-kv line.

noted as less than 3 cycles. Surges in the supply voltage of approximately 1.5 times normal are noted.

CONCLUSIONS

A 230-KV GAS-BLAST SWITCH has been designed and tested under actual service conditions. Analyzing the results of this test program, the following conclusions are to be drawn:

(1) A 230-kv gas-blast switch is capable of successfully interrupting the transformer magnetizing current of a 112,500-kva transformer bank. The performance in switching this size of transformer bank was such that the gas-blast switch no doubt can handle much larger transformer banks. The gas-blast switch also is a useful device for interrupting parallel load current and line charging currents for applications as listed in Tables II and III.

(2) The gas-blast interrupting attachment greatly reduces the length of arc and the reach of arc when compared with the performance of conventional horn-gap switch.[1]

(3) The test program has proved the 230-kv gas-blast switch to be an economical means of isolating transformer banks, switching small blocks of parallel load current, and for dropping as much as 84 miles of 230-kv transmission line.

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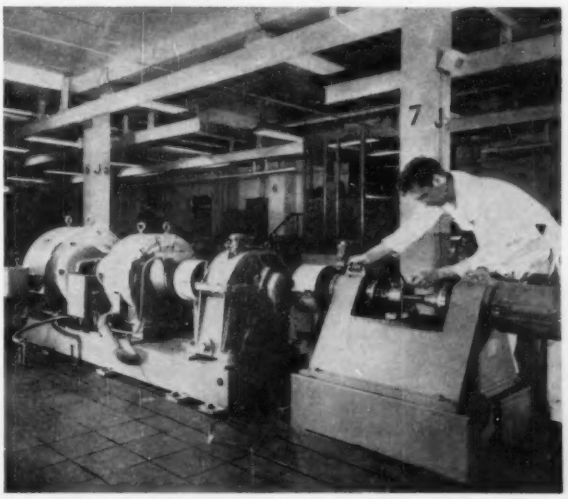
2. A 330-Kv Air Switch, **I. W. Gross, S. C. Killian, J. M. Sheadel.** AIEE *Transactions*, vol. 73, pt. III-A, pp. 264–70.

Tractor Axles and Gears Life Tested by Electronic Method

Endurance of tractor axles and gears is determined in life tests run in the Ford Research and Engineering Center, Dearborn, Mich. In these tests, a power input of about a 137.5-foot-pound torque is maintained by holding rear-axle torque constant at 8,200 foot-pounds while running at 1,500-rpm input speed.

Torque is measured by a Baldwin-Lima-Hamilton Corporation (Philadelphia, Pa.) *SR*-4 torque pick-up, electrically connected into a Baldwin direct-reading indicator in an operating booth (center). An unusual feature of the test method is a heavy mounting fixture for the torque pick-up unit, which maintains exact shaft alignment and prevents interference from frequency characteristics of the shaft couplings under slight misalignment or bending strains from gear reactions in the tractor drive. Normally, the brushes are withdrawn from the slip rings in the pick-up unit and contact the rings only when checking the input torque at regular intervals.



Method for Finding Transmission-Line Faults

M. J. LANTZ
MEMBER AIEE

CALCULATIONS OF FAULT CURRENTS for points along a transmission line are usually prepared for use in fault locating by the current-ratio method or by problems of inductive interference. The ground fault is the type of fault generally required for these purposes.

Mutual induction between circuits complicates these calculations when two or more transmission lines parallel on the same right-of-way. The method described is suitable for mutually coupled circuits up to and including four, providing they have approximate uniform configuration and are all bussed at both ends. It is also applicable to the single line.

Several types of calculation are shown for various metering points and for different data requirements. Required calculations may be the ratio of line residual currents, ratios of transformer neutral currents, actual line residual current values, or actual values of transformer neutral currents.

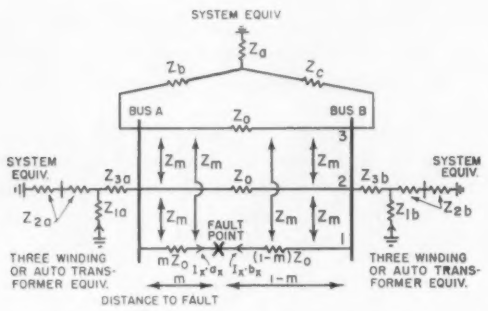
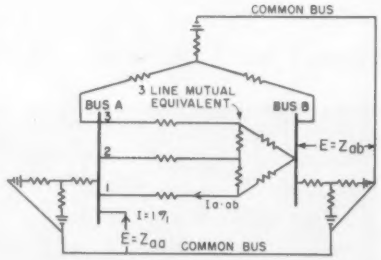


Fig. 1. General representation of problem. *Z in formulas equals total Z_1 or Z_0 of one line.*

Fig. 2. Measurement of constants to a bus.

$Z_{aa}=E$ form common bus to bus A with $I=1$ per unit to bus A; $Z_{ab}=E$ from common bus to bus B with $I=1$ per unit to bus A; Ia. ab = current through line 1 with $I=1$ per unit to bus A.



The determination of the ratio curve, i.e., ratio of fault current from one end of the line to the total current from both ends, for residual line currents is quite simple, since this curve plotted against distance is a straight line and requires a knowledge only of the two terminal bus faults.

For devices located in the transformer neutral circuits, a ratio of one neutral current to the summation of the neutral currents at each end is required; this curve plotted against distance is not a straight line. Considerable calculation is normally required for the multiple circuit problems, requiring current ratios or actual values of fault currents. The proposed method will greatly simplify the required calculation, reducing it to a routine procedure for the desk calculator or a computer.

A zero sequence network with multiple circuits between two points and bussed at these points can be reduced to the form shown in Fig. 1, which shows a sample 3-line mutual problem with 3-winding transformers at each end and indicates the location of the currents to be calculated for various distances m from bus A. The equivalent circuit of the paralleled circuits replace the mutually coupled lines between the terminal busses. Various arrangements of transformer neutral connections and different locations of metering are covered in the calculations by the use of the constant K in the formulas. Starr equivalents for two, three, and four mutually coupled transmission lines and the formulas for the K constants have been determined.

Fig. 2 shows the method of measurement of the circuit impedance and current constants required for the solutions.

After the circuit constants have been determined for the problem, as shown in Fig. 1, constants for the B bus are similarly measured. Several of the ratios and impedance values may be determined for any number of points along the line.

The ratio of residual line current at one end of the line to the total fault current is $mA+B$, where $A = 1 - I_{a.ab} - I_{b.ab}$, and $B = I_{a.ab}$.

The residual line currents are $I_{z.bx} = I_{a.ab} + mA$, and $I_{z.ax} = 1 - I_{a.ab} - mA$.

The ratio of residual current of one neutral to the summation of the neutral currents at both ends is $(mA + B) / (mC + D)$, where $A = K_a (Z_{ab} - Z_{aa})$, $B = K_a Z_{aa}$, $C = Z_{ab} (K_a - K_b) - K_a Z_{aa} + K_b Z_{bb}$, and $D = K_b Z_{ab} + K_a Z_{aa}$.

The actual impedance of the intermediate point is equal to $Z_{xx} = m^2A+mB+C$, where $A = Z_{aa} - 2 Z_{ab} + Z_{bb} - Z$, $B = 2Z_{ab} - 2Z_{aa} + Z$, $C = Z_{aa}$, and Z = impedance of one line. With the network impedances known, the actual currents can be calculated.

All the repetitive calculations are readily adapted to either the calculating machine or computer, since they are an interative process for the equal interval values of m.

Digest of paper 56-629, "Simplified Method for Calculating Intermediate Faults on Mutually Coupled Transmission Lines," recommended by the AIEE Committee on Transmission and Distribution and approved by the AIEE Committee on Technical Operation for presentation at the AIEE Summer and Pacific General Meeting, San Francisco, Calif., June 25–29, 1956. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1956.

M. J. Lantz is with Bonneville Power Administration, Portland, Ore.

Industrial Uses of Germanium Rectifiers

R. M. CRENSHAW
MEMBER AIEE

The versatility of germanium as a rectifying material is demonstrated by its use in such widely varying applications as tiny electronic transistors and 40,000-ampere power supplies. Its industrial uses, particularly in the chemical and metal-working industries, are outlined.

DEVELOPMENTS in the electrical field are being announced at more and more frequent intervals. In this era of rapid technological advancement, a few items may be considered exceptionally outstanding. The germanium power rectifier undoubtedly belongs in this category. Its uses currently range from tiny electronic transistors rated in milliamperes to 40,000-ampere single-rectifier power supplies.

The metallic element germanium was discovered in 1886, but very little use was found for it for many years. Then in the research laboratory, only a few years ago, germanium was rediscovered as the search was intensified for better rectifying materials. After much work by research engineers, the germanium diode was developed. It possesses several outstanding advantages, the most significant of these being high current density, high efficiency, and excellent stability. These advantages are obtained from the peculiar characteristics of this relatively unknown metal, influenced by the method of processing, rather than from any new rectifying principle.

INDUSTRY NEEDS

THE CHEMICAL and metal-working industries have always been the largest users of direct current. The electrochemical processes in both these industries dictate the use of direct current. In addition, the recent trend has been toward more d-c drives to obtain the advantages of more accurate control. Increased automation and higher standards of quality control further increase the demand for d-c power in small quantities for magnetic amplifiers and in large quantities for heavy production.

As the demand for d-c power increased, it was only natural that new types of conversion equipment were sought to supplement conventional types. This evolutionary process produced large mercury-arc rectifiers and mechanical rectifiers. It also expanded the use of the familiar selenium and copper oxide semiconductor rectifiers. And now the germanium rectifier has become an important power supply for high current loads, particularly in the electrochemical industry.

The advent of the germanium rectifier does not mean that other conversion methods are obsolete, but rather that the semiconductor rectifier is now taking its rightful position along with the others. There is a definite field of application for each type of equipment. The semiconductor rectifier is best applied to electrochemical and related steady loads requiring a potential below 250 volts where regeneration is not involved. The motor-generator set still has applications for rotating equipment where a wide speed range is required by armature voltage adjustment. Generators for these applications are rated at 250 volts and above. The mercury-arc and mechanical rectifiers find their best application in the electrochemical industry, where ratings of 250 volts or higher are used. Mercury-arc rectifiers are also used to supply rotating machines in steel mills.

One of the first General Electric industrial germanium power rectifiers was sold and installed in a West Coast electrochemical plant in January 1954.[1] This rectifier operates at 100 volts, 800 amperes, air cooled, and has been in continuous operation on a production line which reclaims tin from tinplate scrap. The performance of this installation provides another verification of the design claims that a germanium rectifier offers considerably higher efficiency and much saving in space compared with other metallic rectifiers or with motor-generator sets. This installation shows an over-all efficiency of 91.5 per cent. Another installation which was designed to operate with liquid cooling at 65 volts, 15,000 amperes realizes over 95 per cent efficiency.

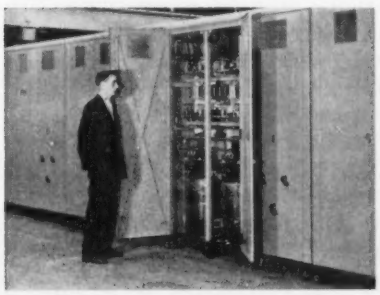
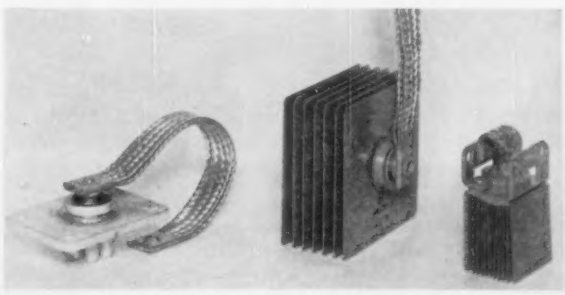


Fig. 1 (left). Germanium rectifier installation at General Electric's Appliance Park. Fig. 2 (right). Hermetically sealed germanium rectifiers.



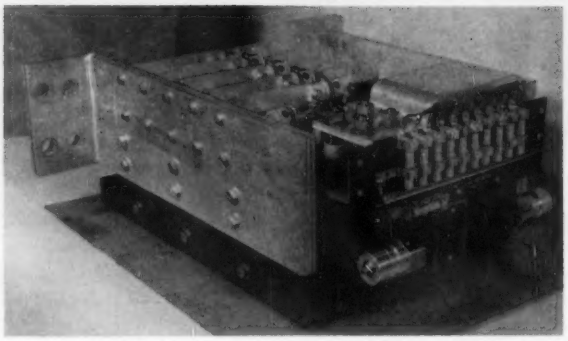


Fig. 3. Germanium rectifier tray.

TYPICAL INSTALLATIONS

AFTER THE EARLY INSTALLATIONS, inquiries and orders came rapidly. Within the short span of two years General Electric had 11,500 kw representing 286,000 amperes of germanium power rectifiers in operation and 11,000 kw, representing 205,000 amperes more on order. The metal-working industry was quick to see the advantage of this new tool and soon began using it. One of the early units was rated 12,000 amperes at 65 volts, another was rated 30,000 amperes, 65 volts, both used for hydrogen-oxygen production. One of these is in a steel mill where the gas is used for annealing steel strip. Four units, each rated 5,000 amperes at 12 volts have been installed on the plating tanks of electrolytic tin lines at two different steel mills.

There are three installations supplying d-c arc melting furnaces for titanium, the largest of these being rated 8,000 amperes at 60 volts, full load. Reactors in the a-c line effectively limit output current for electrode short-circuit conditions. One of the largest installations to date in magnitude of current, rated 45,000 amperes at 12 volts, is used for chromium plating. Another large installation, Fig. 1, is used in General Electric's Appliance Park plant at Louisville, Ky. It is rated 40,000 amperes at 24 volts and is used for aluminum anodizing. A West Coast chemical plant recently ordered an equipment rated 30,000 amperes at 150 volts, with provision for enlarging the capacity later. The power will be used for chlorine production.

The application horizon continues to broaden as manufacturing technique and operating experience highlight the advantages of germanium. For example, a recent order calls for an equipment to supply a developmental aluminum potline with 90,000 amperes at 65 volts. It is expected to be in operation within a few months.

THE RECTIFYING DEVICE

THE POWER GERMANIUM CELL is made from a 0.020-inch thick wafer sliced from a highly purified single crystal of germanium. Ferni discs are soldered to each side of the wafer; on one side only, indium is a constituent of the solder. The indium alloys with some of the germanium, thus creating a junction within the germanium wafer at which there is a barrier layer across which electrons flow far more freely in one direction than the other. In this manner a semiconductor rectifying device is created. When properly cooled, this rectifier can be used at current densities almost 1,000 times higher than selenium and will withstand a much higher inverse voltage per cell than either selenium or copper oxide. The manufacture is carried out under exacting conditions of cleanliness. The process of growing the germanium crystal and performing the soldering operations and subsequent heat treating requires much care and skill. Each cell is subjected to quality control tests at various stages in the fabrication and upon completion.

The forward voltage drop of a germanium cell is very low while the ratio of forward to reverse resistance is in the order of 1 to 400,000, which far exceeds the ratio of other metallic rectifiers. Such characteristics make possible the high efficiency and low voltage regulation for which these cells are noted. The rectifier cell alone shows an efficiency of the order of 98 per cent, when operated at maximum rated voltage. Operation at the high current density means that the rectifier active element can be very small. By way of comparison, it is astounding to discover that a germanium cell the size of a dime can rectify an average half-wave current of at least $83^1/_3$ amperes when mounted on a radiating surface that is properly cooled. The cooling method determines the actual rating.

COOLING

ALTHOUGH THE LOSSES ARE SMALL, it can be seen that even the small amount of heat generated in this extremely small area must be dissipated rapidly. In order to dissipate the heat, as well as provide an electrical connection, the cell is usually mounted on a copper block with radiating fins attached (Fig. 2). A flexible braid is provided for the other connection. The high inverse-voltage rating permits the use of single cells connected in a full-wave bridge to supply d-c output up to 75 volts.

When output voltage greater than 75 is required, it has been the practice to connect two individual power supplies in series, giving a maximum d-c output of 150 volts; of course, this requires two transformer secondary windings. Continuing development work has now proved that individual cells can be operated in series for higher output voltages. In those cases where output ratings higher than 150 volts are required, series operation of cells now appears more economical than the use of multiple transformer windings.

The earliest installations consisted of forced air cooled, 25-kw packaged units connected in parallel. The demand for much higher current ratings came very rapidly, so liquid cooling was soon adopted as the most effective way to obtain maximum output and minimum space (Fig. 3). When liquid cooled, usually 24 cells are arranged in a tray and the tray is filled with an insulating liquid. A standard water-cooled heat exchanger is used to remove the heat as the liquid is circulated by a pump.

A recent improvement in cell design has produced the hermetically sealed cell. This feature greatly increases cell

Essentially full text of a conference paper "The Germanium Rectifier Is Growing Up," presented at the AIEE Summer and Pacific General Meeting, San Francisco, Calif., June 25–29, 1956.

R. M. Crenshaw is with the General Electric Company, San Francisco, Calif.

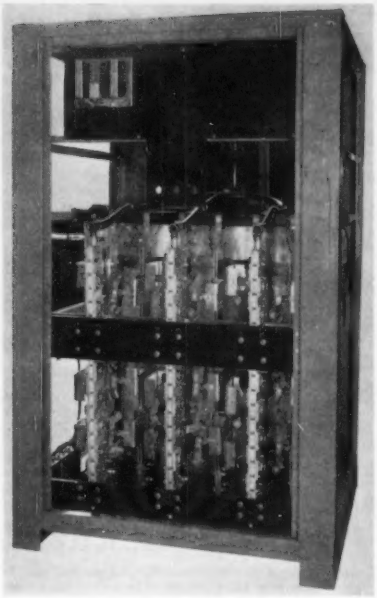


Fig. 4. Germanium rectifier, direct water cooled.

protection against moisture and eliminates the need for an insulating coolant. One type of mounting utilizes a block of aluminum with prongs which are in direct contact with cooling water. The aluminum mounting channel doubles as a cooling water pipe and electrical conductor (Fig. 4). No heat exchanger is needed unless the available cooling water is corrosive. The advantages of this design, now being supplied on most new orders, are elimination of special fluid and a simplified cooling circuit; in addition, the cells are much more accessible.

CELL PROTECTION

BECAUSE SUSTAINED SEVERE OVERLOAD or fault current would cause permanent cell damage, high-speed current limiting fuses are installed in series with individual or pairs of cells. If a cell should fail, fuses will blow to isolate the fault and prevent damage to other cells. Each fuse has a companion trigger fuse, which provides visual indication and sets up an alarm circuit when any fuse opens (Fig. 3).

POWER SUPPLY AND CONTROL

WHEN THE A-C POWER SUPPLY is less than 1,000 volts, the transformers are installed in the rectifier cubicle, providing a compact unit. When a higher voltage is used, the transformer is a separate unit especially designed with secondary windings to suit the rectifier. An enclosed busway connects it to the rectifier cubicle.

The electrochemical applications usually require a wide range of adjustment of rectifier output voltage. Sometimes manual adjustment is sufficient and can be obtained by transformer taps or manual operation of an induction regulator. More often, the process requires close regulation of output voltages or current over an adjustable range dictated by the end product. Induction voltage regulators, step voltage regulators, or load-ratio-controlled autotransformers, equipped with necessary automatic control features, are often engineered and supplied with a rectifier for a specific application. The saturable reactor is also widely used because it offers infinite adjustment over a wide range and is also adaptable to automatic regulation. For rectifiers rated less than 200 kw, the saturable reactor is often more economical than other methods, particularly where a wide range of adjustment is required.

CONCLUSIONS

THE GERMANIUM RECTIFIER has proved itself beyond expectations after more than 5 years of life tests and $2^1/_2$ years of actual operation in industry. There is practically no sign of aging. Efficiency remains high, operating experience indicating from 88 to 95 per cent, depending on operating voltage and auxiliary equipment included.

Equipments are offered in a variety of ratings and higher voltages are becoming feasible with series cell operation. At the other extreme, units are available in air-cooled design for plating loads in ratings ranging from 6 to 24 volts at 750 to 4,000 amperes, still showing efficiencies of about 88 to 90 per cent. These plating units incorporate an automatic voltage control by means of a saturable reactor.

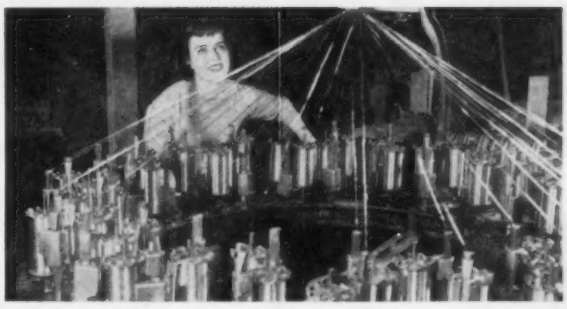
SILICON RECTIFIERS

THIS REPORT would not be complete without a word regarding the status of silicon rectifiers. Because of the rapid advances just described in the field of semiconductor rectifiers, any new development is greeted with enthusiasm. Silicon as a rectifying material is another new development which holds much promise. Silicon rectifier cells are now being made in limited quantities. One of the advantages of silicon is the ability to operate at a considerably higher temperature than other types.

REFERENCE

1. Application of Germanium Power Rectifiers, **R. M. Crenshaw.** AIEE *Transactions* vol. 74, pt. II, 1955, pp. 48–52.

Industrial "Maypole"



The "maypole" appearance of this wire-braiding machine captures interest at the General Electric Company's wire mill in Schenectady, N. Y. The machine's 48 spools reel off 45 miles of 0.005-inch wire an hour. The mill recently produced its 12 millionth mile of wire—enough to go around the world 500 times.

INSTITUTE ACTIVITIES

Kansas City Will Be Host to Petroleum Industry Conference

THE THIRD ELECTRICAL CONFERENCE of the Petroleum Industry will be held in Kansas City, Mo., September 17–19, 1956. Headquarters for the conference, which is sponsored by the AIEE, will be the Muehlebach Hotel.

Arrangements have been made for an exhibition hall where electrical equipment used in the petroleum industry will be displayed. Those interested in obtaining space for exhibits should contact F. S. Jones, Platte Pipe Line Company, 1200 Power and Light Building, Kansas City, Mo.

A block of tickets to the ball game between the Kansas City Athletics and the Boston Red Sox has been secured for Tuesday evening, September 18. Advance registration cards will include provisions for reserving tickets to the ball game. Busses will leave the Muehlebach Hotel at 7 p.m. for the game, which will begin at 8 p.m.

Ladies are invited to attend and a full program is being planned for their enjoyment.

Committee

The members of the 1956 Conference Committee are: L. E. Oberhelman, Standard Oil Company, chairman; A. R. Heidebrecht, Platte Pipe Line Company, vice-chairman; E. W. Brunton, Black and Veatch, secretary-treasurer; R. E. Burlingame, J. F. Pritchard and Company, budget and finance; F. S. Jones, Platte Pipe Line Company, exhibit; A. A. Dahms, Allis-Chalmers Manufacturing Company, program; M. L. Lippert, C. W. Nofsinger Company, registration and hotel; A. H. Rector, Burns and McDonnell, inspection trips and transportation; F. B. Minx, Wagner Electric Corporation, printing and programming; G. C. Schuefele, Black and Veatch, publicity; Mrs. B. J. Ennis, ladies activities; and R. S. Gardner, AIEE Headquarters representative.

The officers of the Committee on Petroleum Industry are J. Z. Linsenmeyer, chairman; R. S. Cannon, vice-chairman; and E. E. Hogwood, Jr., secretary.

The tentative technical program for the conference is as follows:

Sunday, September 16

4:00–6:00 p.m. Registration—Lobby

Monday, September 17

8:00–4:30 p.m. Registration—Lobby

10:00 a.m. General Session—Grand Ballroom

Presiding: L. E. Oberhelman, Standard Oil Company

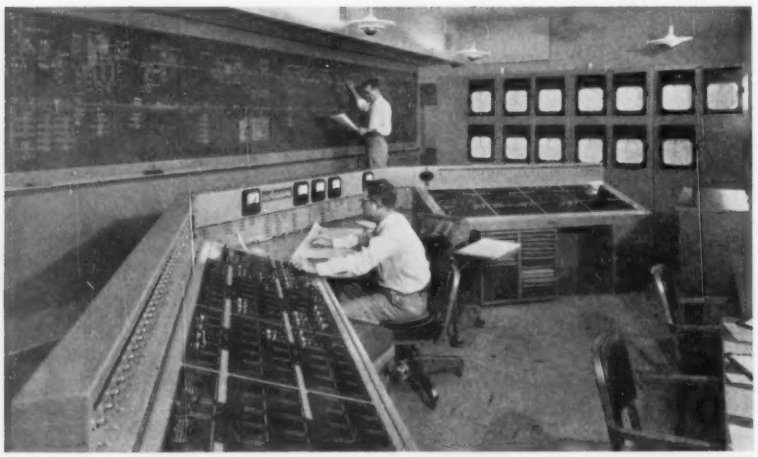
Welcome Address: H. R. Bartle, mayor, City of Kansas City, Mo.

Keynote Address: Dr. C. N. Kimball, Midwest Research Institute

11:00 a.m. Refining—Grand Ballroom

Presiding: W. H. Dickinson, Esso Research and Engineering Company

Adequate and Economical Electrical Design and Application in Refineries. *E. C. Benjamin*, M. W. Kellogg Company



DISPATCHING CONSOLE receiving telemetered pipeline pressures and controlling operation of repressuring stations at the Platte Pipe Line Company, Kansas City, Mo. An inspection trip to this company will be made during the AIEE Electrical Conference of the Petroleum Industry.

12:00 Noon Luncheon

Presiding: R. S. Cannon, with H. K. Bowers assisting

Oil Men's Club of Kansas City as Invited Guests

Speaker: M. K. Neptune, Sahara Petroleum Company, Alexandria, Egypt, "Experiences and Impressions of the Over-all Middle East Situation"

2:00 p.m. Refining

Presiding: W. H. Dickinson, Esso Research and Engineering Company

Trends in Switchgear Applications for Refineries. *J. Dunki-Jacobs, D. S. Brereton*, General Electric Company

Application of Aluminum in Metal Enclosed Switchgear and Bus Duct. *C. L. Carlson, R. H. Rutter*, Westinghouse Electric Corporation

Adequate Design and Proper Application of Insulated Aluminum Wire and Cable. *H. R. Stoddard, R. E. Gross, G. A. Snow*, Simplex Wire and Cable Company

Advantage of Silicone Rubber Insulation for Large Motors and Generators. *J. E. Kuehlthau*, Allis-Chalmers Manufacturing Company

2:00 p.m. Production

Presiding: M. H. Halderson, Phillips Petroleum Company

Sizing Electric Induction Motors for Oil Well Pumping. *F. W. Beech*, Cities Service Oil Company

Anti-Moisture Sealing of Class A Motor Windings. *C. H. Eckel*, Humble Oil and Refining Company

One Oil Company's Experience With 762 Volt Electric Pumping Power. *C. A. Bingham*, Continental Oil Company

Grounding of Electric Oil Field Distribution Systems. *G. A. Smith*, Shell Oil Company

2:00–4:30 p.m. Field Trip

Platte Pipe Line Company, Kansas City Office, 14th and Baltimore

Great Lakes Pipe Line Company, Kansas City, Kansas Station—Fairfax District

6:00 p.m. Social Hour—Colonial Room

7:00 p.m. Conference Banquet—Colonial Room

Toastmaster: J. Z. Linsenmeyer, Westinghouse Electric Corporation

Speaker: Dr. N. N. Royall, Jr., University of Kansas City, "Shadow of the Coming Industrial Revolution"

Tuesday September 18

9:00 a.m. Refining

Presiding: F. C. Somers, Atlantic Refining Company

A Stability and Voltage Study to Determine the Performance of an Oil Refinery Distribution System. *D. Dalasta*, Allis-Chalmers Manufacturing Company

Non-Explosion Proof Motors in Refining Areas. *E. Talley*, Esso Standard Oil Company

New High Interrupting Capacity Molded Case Circuit Breaker. *W. H. Edmunds*, I-T-E Circuit Breaker Company

9:00 a.m. Transportation—Colonial Room

Presiding: A. R. Heidebrecht, Platte Pipe Line Co.

Purchased Electric Power Vs. Privately Generated Power. *W. H. Steuve*, consulting engineer

Electric Power Analysis for Products Pipe Line Terminals. *A. E. Whiteside*, Great Lakes Pipe Line Company

Silicone Insulation for New Electrical Equipment. *J. F. Dexter*, Dow Corning Corporation

A report on an AIEE Transportation Subcommittee Project: "Standardization of Device Numbers and Functions for Pipe Line Pump Stations Under Automatic or Remote Control," M. A. Hyde, Westinghouse Electric Corporation

9:00–11:00 a.m. Field Trip

General Motors B.O.P. Plant

12:00 Noon Luncheon—Parlor A

Committee on Petroleum Industry Business Meeting, J. Z. Linsenmeyer, chairman; R. S. Cannon, vice-chairman

2:00 p.m. Refining

Presiding: F. C. Somers, Atlantic Refining Company

Designing for Locations Having Group B Gases. *E. R. Hoyle*, Sinclair Refining Company; *R. S. Northup*, Crouse-Hinds Company

Viewpoint on API Standard RP-500 by a Member of NEC Code Making Panel No. 14. *C. M. Park*, NFPA Electrical Section, Mill Mutual Fire Prevention Bureau

Economic Study of Preventive Maintenance in Petroleum Refineries. *J. C. Hitt, A. D. Mustillo*

Economics Resulting from the Use of Two-Way Radios in Refineries. *L. F. Stanley, E. C. Williams*, Standard Oil Company

2:00 p.m. Production

Presiding: M. H. Halderson, Esso Research and Engineering Company

A Simplified Diesel-Electric Land Drilling Rig. *W. E. Withers*, Sun Oil Company

Application and Control of D-C Machines to Drilling Rigs. *B. H. Hefner*, General Motors Corporation

2:00 p.m. Transportation

Presiding: A. R. Heidebrecht, Platte Pipe Line Company

Transient Voltages and Power Line in Pipe Line Stations and Similar Installations. *E. B. Turner*, General Electric Company; *D. S. Brereton*, General Electric Company

Overloading of Power Transformers. *J. B. Hodtum*, Allis-Chalmers Manufacturing Company

Progress to Date on an Electrical Operator for Throttle Valves. Presentation by manufacturers of throttle valve operators—J. N. Morrell, E-I-M Company; A. Brothman, Techniflex Corporation; Manning, Maxwell & Moore, Inc.; W. A. Holzbock, Askania Regulator Company; Mason-Neilan Regulator Company

3:30–5:00 p.m. Field Trip

Midwest Research Institute, Kansas City, Mo.

Wednesday September 19

9:00 a.m. Transportation—Grand Ballroom

Presiding: A. R. Heidebrecht, Platte Pipe Line Company

Symposium: "Remotely Operated Pipe Line Stations"

"The Engineer's Responsibility in Automation Design," F. S. Jones, Platte Pipe Line Company

"Points of Justification for Remote Control," W. W. Holt, Jr., Plantation Pipe Line Company

"Review of Existing Systems and a Preview of Future Remote Control Equipment," Max Nigh, Service Pipe Line Company; R. J. Osborn, Sinclair Pipe Line Company; F. S. Jones, Platte Pipe Line Company; T. V. Bockman, Plantation Pipe Line Company

"Telemetering as Practiced by Sohio Pipe Line Company," W. N. Sorensen, Sohio Pipe Line Company

Courtes Randazzo and Morrison, Inc.

NIGHT SKYLINE of downtown Kansas City, Mo., where the third AIEE Electrical Conference of the Petroleum Industry will be held September 17–19, 1956.

"Digital Telemetering and Print-Out of Pipeline Information," M. T. Nigh, Service Pipe Line Company

In-Station Control and Equipment Protective Devices," A. J. Baden, Sinclair Pipe Line Company

9:00 a.m. Production

Presiding: M. H. Halderson, Phillips Petroleum Company

Experience with a System for Automatic Lease Custody Transfer of Crude Oil. *G. G. Hebard*, Phillips Petroleum Company

Controlled Automatic Lease Operation. *P. W. Truman*, Sinclair Oil and Gas Company

Automatic Control for Off-Shore Operations. *F. S. Bird*, The California Company

9:00–12:00 Noon Field Trip

Phillips Refinery, Kansas City, Kan.—Fairfax District

1:00–4:00 p.m. Field Trip

Sinclair Pipe Line Company, Gunn Station—Harrisonville, Mo.

2:00 p.m. Meeting

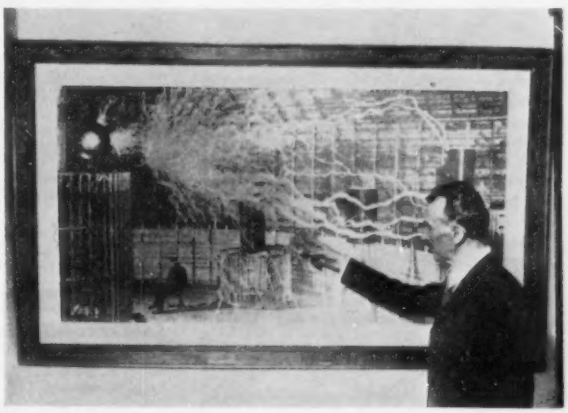
Subcommittee chairmen to meet with their committees to plan for 1957 conference

Fall General Meeting To Celebrate Tesla Centennial

COMMEMORATION OF Dr. Nikola Tesla's 100th anniversary will be made at the AIEE Fall General Meeting to be held in Chicago, Ill., October 1–5 at the Morrison Hotel. Members of the Tesla Society will be present to help honor the man who developed the present polyphase a-c systems.

Technical Sessions

Over 50 sessions will be held covering a wide range of electrical interests. At present, it is planned that six parallel sessions will be functioning to include as broad a coverage of electrical subjects as possible. A cross section of the tentative schedule reveals such subjects as rotating machinery, protective devices, metallic rectifiers, insulated conductors, dielectrics, air transportation, land transportation, switchgear, feedback and control systems, electronics, com-



DR. NIKOLA TESLA pointing to a picture of his secret research laboratory at Colorado Springs, Colo., where he produced the most powerful electrical discharges achieved by man, surpassing natural lightning. There he discovered standing waves in the earth and found how to produce intense electrical activity from this effect. His 100th anniversary will be commemorated at the Fall General Meeting.

Courtesy American Airlines, Inc.

DOWNTOWN CHICAGO, ILL., as it appears to sky travelers coming in over the lake front enroute to Midway Airport. In the background *(right)* is Chicago's newest skyscraper, the Prudential building. This city will be host to the AIEE Fall General Meeting, October 1–5, 1956.

puting devices, nucleonics, and many others, including management sessions.

Because of the closer relationships which are binding the sciences together, all AIEE members are invited to attend the 12th annual National Electronics Conference, October 1–3 at the Hotel Sherman in Chicago, Ill. There will be more than 100 technical papers and 240 exhibits. The Fall General Meeting will thus give those attending a chance to broaden their outlook.

Inspection Trips

Many inspection trips to electric utilities, telephone, radio, large manufacturing, and food industries are planned. One such trip is already scheduled to Commonwealth Edison's Ridgeland Station. The new and highly efficient cyclone furnaces will be seen there, four on each boiler, which together consume 750 tons of coal daily.

Fall Frolics

Plan to spend Wednesday evening at the Fall Frolics, the main social event of the Fall General Meeting. The committee is sure that everyone will enjoy the dinner, the entertainment, and the dancing.

For those who want to see some of Chicago's many interesting sights and relax a little before the meeting begins, a Get-Acquainted Tea will be held on Sunday.

The ladies' committee is planning varied activities which should make the meeting a memorable occasion for the wives who attend as well as the husbands.

Getting to sessions will be much easier this year. The entire mezzanine floor of the Morrison will be assigned for a registration area, and for technical session meeting rooms. This area is a one-floor walk-up from the lobby, and, therefore, delays due to loaded elevators will be eliminated.

1956 Telemetering Conference To Be Held in Los Angeles, Calif.

THE 1956 National Telemetering Conference will be held August 20–21 at the Biltmore Hotel, Los Angeles, Calif. The conference, sponsored by the AIEE, the Institute of Radio Engineers (IRE), the Institute of the Aeronautical Sciences (IAS), and the Instrument Society of America (ISA), will offer a program of technical sessions on systems, data processing, components and equipment, and recorders.

The banquet address, "Telemetering and Pointer Readings," will be delivered by Dr. C. R. Piori on Monday evening, after Dr. H. L. Hull, chairman of the 1956 conference, has welcomed those attending. At the luncheon on Tuesday, E. R. Toporeck will speak on the subject of "Ballistic Missile Telemetry."

The registration fee for the conference is $3 for members of AIEE, IRE, IAS, and ISA, and $4 for nonmembers. Registration chairman is E. W. Robischon, 7660 Beverly Blvd., Los Angeles 36, Calif.

The tentative technical program is as follows:

Monday, August 20

Morning

Session I—Systems I

A Wide Bandwidth Telemetry System. *D. E. Henry*, Sandia Corporation

Advanced Design Telemetry for Vehicles Subjected to Severe Environmental Conditions. *D. W. Blancher*, Bendix Pacific

Radio Frequency Link Design for Telemetering. *Hans Sciarla-Nielsen*, Radiation, Inc.

Beacon Telemetering System. *Stanley Berinsky*, Stavid Engineering

A Comparison of Transmission Quality in Multiplexed Telemetering Systems. *H. S. McGaughan*, Naval Ordnance Laboratory

Session II—Data Processing

A New Development in the Processing of PDM Telemetry Data. *W. E. Lever*, Douglas Aircraft Co.

An Automatic Data Reduction System for Pulse Width Telemetry. *F. T. Chambers, III*, Applied Science Corporation of Princeton

A Method of Separating Vibration Data into It's Frequency and Amplitude Components. *J. M. Hawk*, White Sands Proving Ground

A High-Speed, High-Accuracy Automatic Digital Data Reduction System for FM and PWM Telemetered Information. *William Kroll*, Lockheed Aircraft Corporation

Afternoon

Session III—Components and Equipment I

Temperature Measurements on High Speed Missiles. *G. E. Reis*, Sandia Corporation

Measurement of Millivolt Data by Pulse Width Multiplexing. *A. S. Estneat*, Applied Science Corporation of Princeton

Commutation and Amplification of Low Level Signals. *W. J. Ross*, Bendix Aviation

A Method for Commutating Low Level Signals. *Owen Ott*, Electro-Mechanical Research, Inc.

Frequency Stability Investigations on FM/FM Telemetering Equipment. *J. W. Prast, Dr. K. F. Hartmann*, Bell Aircraft Corporation

Session IV

Panel: "Crowding of the Telemetering Frequency Bands," G. S. Shaw, Radiation, Inc., chairman

Evening—Banquet

Welcome: Dr. H. L. Hull, chairman 1956 NTC, Farnsworth Electronics Company

Address: Dr. C. R. Piori, AVCO Manufacturing Corporation, "Telemetering and Pointer Readings"

Tuesday, August 21

Morning

Session V—Systems II

An Integrated Sub-Miniature Digital Airborne Ground Data Transmission System. *R. M. Gordon*, Epsco Inc.

Pulse Coded Messages Over Radar Beacon Equipments. *Kurt Merl, Richard Rabin*, Ford Instrument Company

A Comparison of Encoding Techniques for Telemetry and Data Handling. *R. A. Runyan*, Electro-Mechanical Research, Inc.

A Wide Band Radio Link Telemetering System. *T. D. Warzecha*, Convair

Session VI—Recorders

A High-Speed, General-Purpose, Mobile Magnetic-Tape Data Recorder for Use with A Digital Computer. *E. R. Pelta*, The Rand Corporation

Direct Writing Continuous Recording Above 100 Cycles. *H. I. Chambers, J. C. Riedel*, Consolidated Electrodynamics Corporation

A Miniature Digital Recorder. *C. P. Hedges*, Aerophysics Development Corporation

A Small, Fast Digital Data Printer. *E. A. Hilton, Harold Elliott*, Hewlett-Packard Company

Noon—Luncheon

Luncheon talk: E. R. Toporeck, Ramo-Woolridge Corporation, "Ballistic Missile Telemetry"

Afternoon

Session VII—Components and Equipment II

Receiver Design Considerations for Future Telemetry Requirements. *R. E. Grimm*, Nems-Clarke, Inc.

A Continuously Tunable Discriminator for FM-FM Telemetering Systems. *G. E. Tisdale*, Electro-Mechanical Research, Inc. .

A Transistorized Telemetering System as a "Watch Dog" on Guided Missile Performance. *F. M. Riddle*, Jet Propulsion Laboratory

Transistors Applied to an Operational FM-FM Telemetry System. *C. B. McCampbell, R. H. Gablehouse, P. S. Scheele, R. P. Matthews*, Sandia Corporation

Session VIII

Panel: "Telemetry Flight Testing of Piloted Aircraft," J. J. Dover, Air Force Flight Test Center, chairman

"Vault for Future" Contains Letter by the President of AIEE

A letter written by AIEE President M. D. Hooven to the President of the Institute in 2055, *Electrical Engineering*, page 98, January 1956, has been placed in the "Vault for the Future" at The George Washington University, Washington, D. C.

Mr. Hooven's letter was one of the evidences of technology and engineering in the nation's capital sealed June 20 in the "Vault," which was dedicated at the Tompkins Hall of Engineering, The George Washington University. The vault, which will remain sealed for 100 years, contains contributions by engineering societies, Government agencies, and others. The electrical engineering evidence, including a Report of the Board of Directors of the AIEE, a copy of *Electrical Engineering*, a description of the Potomac Electric Power Company, and of the Bryant Street Pumping Station, and evidence of present-day telephone and telegraph communications, computers, lighting, and a copy of the National Electric Code, was gathered by the Washington Section of AIEE, and sealed in a separate copper box. The committee assembling the electrical materials was composed of D. C. Vaughan (F '48), G. L. McKinley (M '47), and W. J. Ellenberger (M '38).

The vault project was conceived by Dr. C. H. Marvin, president of the University, and has been more than a year in the making.

Mr. Hooven's letter, addressed "To the President of the American Institute of Electrical Engineers in the year 2055," underscored the possibility of doubling the supply of engineers and scientists by including more women in the profession.

He went even a step further by envisioning a woman as president of the world-wide Institute a century hence. The AIEE now has a membership of more than 49,000—most of them males. Of the more than 1,500 Fellows of the Institute, all are men, except Prof. Edith Clarke, of the University of Texas, Austin, Tex.

In part, the letter says: "Dear Sir or Madam: ...Simple arithmetic, however, shows that if we are to meet the demands for scientists and engineers which your generation will present to the community, we must consider doubling our basic source of supply by taking in the womenfolk. Their acknowledged superiority in intuition and flexibility of mind might very well contribute extraordinarily to the electrical engineering profession."

Mr. Hooven assured the Institute President of 2055 that there is little danger that the machine will master man. "The majority of us," he wrote, "are quite sure that we are addressing you, our successors, as the continued Masters of the Machine, asserting your intellectual control over the physical universe without too much fuss and furor."

N. Y. Power and Industrial Division Attends Luncheon

Officers and committeemen of the New York Section's Power and Industrial Division attended an organization luncheon on June 12 at the Engineers Club. The purpose of the meeting was to introduce all the committeemen and to foster a better understanding of the work they do.

The responsibilities and operations of each of the various committees within the Division were described by the respective chairmen. J. R. Kerner, secretary of District 3, as principal speaker, outlined the importance of committee work and its function within the national society.

Ross Photos

THE NEW YORK SECTION'S Power and Industrial Executive Committee at an organization luncheon are: *(left to right)* J. J. Anderson, Headquarters; S. Friend, member at large; S. H. Grim, secretary; L. E. Gray chairman, Educational Committee; H. W. Marquardt, chairman, Program Committee; S. J. Dolega, chairman, Related Activities Committee; A. Paullow, chairman, Publicity Committee; M. Lenning, member at large; G. F. Sievers, treasurer; D. E. Sullivan, vice-chairman; and J. C. Hoyt, chairman.

Future AIEE Meetings

AIEE-IRE-ISA–IAS Telemetering Conference*
Biltmore Hotel, Los Angeles, Calif.
August 20–21, 1956

Electrical Conference of the Petroleum Industry*
Muehlebach Hotel, Kansas City, Mo.
September 17–19, 1956

AIEE-IRE Industrial Electronics Conference*
Hotel Manger, Cleveland, Ohio
September 24–25 1956

AIEE-IRE-RETMA National Electronics Conference*
Hotel Sherman, Chicago, Ill.
October 1–3, 1956

Fall General Meeting*
Morrison Hotel, Chicago, Ill.
October 1–5, 1956

AIEE-IRE Conference of Magnetism and Magnetic Materials
Hotel Statler, Boston, Mass.
October 16–18, 1956
(Final date for †TP—closed, ‡CP Syn.—Aug. 3, CPMs—Aug. 13)

Machine Tool Conference
Sheraton Gibson Hotel, Cincinnati, Ohio
October 22–24, 1956
(Final date for †TP—closed, CP Syn.—Aug. 8, CPMs—Aug. 17)

AIEE-IRE-ISA Conference on Electronic Technology in Medicine and Biology
Gov. Clinton Hotel, New York, N. Y.
November 7–9, 1956
(Final date for †TP—Aug. 10, ‡CP Syn.—Aug. 24, CPMs—Sept. 4)

AIEE-IRE Eastern Joint Computer Conference
Hotel New Yorker, New York, N. Y.
December 10–12, 1956
(Final date for †TP—Sept. 12, ‡CP Syn.—Sept. 26, CPMs—Oct. 5)

Winter General Meeting
Hotel Statler, New York, N.Y.
January 21–25, 1957
(Final date for †TP—Oct. 24, ‡CP Syn.—Nov. 8, CPMs—Nov. 16)

North Eastern District Meeting
Pittsfield, Mass.
May 1–3, 1957
(Final date for †TP—Feb. 1, §DP Syn.—Feb. 15, DPMs—Feb. 25)

Middle Eastern District Meeting
Dayton, Ohio
May 7–9, 1957
(Final date for †TP—Feb. 8, §DP Syn.—Feb. 22, DPMs—March 5)

Summer General Meeting
Montreal, Que., Canada
June 24–28, 1957
(Final date for †TP—March 26, ‡CP Syn.—April 11, CPMs—April 19)

*Final date for submitting paper—closed
†TP—Transactions paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
(The CPSyn. date is 10 days before the CPMs date)
§DP Syn.—District Synopsis
DPMs—District Manuscript
(The DPSyn. date is 10 days before the DPMs date)

INCOMING AND OUTGOING members of the Lehigh Valley Section's Board of Managers at a dinner meeting on May 25, *(seated, left to right)* H. R. Steward, I. M. McNair, H. Landsman, L. L. Nonemaker, F. S. Fehr, S. C. Townsend, D. L. Greene, B. B. Kern *(standing, left to right)* R. H. Keith, H. D. Moore, J. W. Gehrke, R. E. Peterson, J. A. G. Oewel, A. W. Plonsky, J. C. Gray, R. B. Roush, G. E. May, C. J. Mayer, J. K. McDonald, R. H. Demmy, P. H. Robbins, C. L. Eichenberg, R. L. Emery, E. P. Winkelspecht, E. L. Stagliano, H. W. Leas, E. Hansen, L. F. Geiger, J. C. Engle, W. F. Mackenzie, R. H. Greame, L. F. Anderson, G. A. Irland, and H. F. Moore

Lehigh Valley Section Elects Officers for 1956–57

At the Lehigh Valley Section Board of Managers annual meeting, held May 25, S. C. Townsend, 1955–56 chairman, announced the officers that have been elected for 1956–57. They are F. S. Fehr, chairman; L. F. Anderson, B. B. Kern, and I. M. McNair, vice-chairmen; and L. L. Nonemaker, secretary-treasurer. Division managers are J. C. Gray, Allentown; C. L. Eichenberg, Bethlehem; R. H. Keith, Easton; W. F. Mackenzie, Hazleton; M. A. Buchta, Reading; R. H. Demmy, Scranton; J. C. Engle, Sunbury; D. D. Smith, Wilkes-Barre; and H. F. Moore, Williamsport.

AIEE and IRE Will Sponsor Industrial Electronics Symposium

The fifth annual Industrial Electronics Symposium will be held at the Hotel Manger, Cleveland, Ohio, September 24–25, 1956. Beside the AIEE, the Symposium will be sponsored by the Institute of Radio Engineers (IRE) and the IRE Professional Groups on Industrial Electronics and Production Techniques.

There will be four sessions in the technical program: electronic equipment design; automatic production; testing, gauging, and process control; and data reduction and analysis. Four papers per session are planned.

The speaker at the luncheon on the first day will be B. W. Chidlaw, vice-president, Thompson Products, Inc., formerly Commanding General of the Continental Air Defense Command. His subject will be "Electronics in Air Defense and Air Offense."

The IRE Professional Group on Industrial Electronics will present its annual award for the best paper presented. All registrants will receive a copy of the Symposium Transactions.

The Women's Auxiliary of the AIEE Cleveland Section has arranged an interesting program for the ladies.

The complete program for the Symposium will be published in the September 1956 issue of *Electrical Engineering*.

For additional information, contact C. F. Schunemann, Thompson Products, Inc., 2196 Clarkwood Road, Cleveland 3, Ohio.

MEMBERS OF THE Planning Committee for the fifth annual Industrial Electronics Symposium to be held in Cleveland, Ohio, September 24–25, are *(left to right)* C. F. Schunemann, publicity chairman; Reuben Kazarian and B. M. Jones, co-chairmen; F. A. Furfari, local arrangements chairman; R. C. Rodgers, technical program chairman; and H. C. Martin, finance chairman.

Bimonthly Publications

The bimonthly publications, *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems*, contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

Additional Conference Papers Are Now Available

The following is the list of conference papers presented at the 1956 North Eastern District Meeting which were not numbered at the time of the meeting. They have now been numbered and are available to members for 40¢, and to nonmembers for 80¢. Send order and remittance to: AIEE Order Department, 33 West 39th Street, New York 18, N. Y.

North Eastern District Meeting, May 2–4, 1956, Rochester, N. Y.

DP56-607 Silco-Flex—New Insulation System for Electrical Rotating Equipment. *J. Kuhlthau*

588 Recent Developments in Insulator Manufacture. *D. Alexander*

612 The New Lapp High Voltage Laboratory in High Voltage Insulation Design. *J. H. Moran*

594 Design of Control Systems for Nuclear Reactors. *R. N. Brey*

619 Observation of European Electrical Practices. *G. Steeb*

592 Auxiliary Equipment for Power Transformers. *Saul Bennon*

616 Choosing the Power Transformer. *L. W. Schoenig*

609 Electrical Equipment for Machine Tools. *H. L. Lindstrom*

606 An Improved Method of Phase Failure Protection of Electric Motors. *Dr. W. Knisl*

602 Current Trends in Modern Vertical Transportation. *H. C. Hickock*

600 Experience in Operating Industrial Distribution Systems Ungrounded. *J. A. Ginger*

601 A Device To Detect the Minimum Intelligible Signal in the Presence of Noise. *L. M. Harris, J. E. Evans*

617 The Synchroscan: A New High-Speed Supervisory System for Railway Signaling. *H. C. Sibley*

603 The IBM Magnetic Drum Data-Processing Machine, Type *650*, Engineering and Design Considerations. *E. S. Hughs, R. W. Avery*

598 Repeated Stimulus Generator for Psychological Research. *C. H. Dawson*

613 Recent Developments in Electrical Measurements and Control of Relative Humidity. *C. E. Ohlheiser*

590 Synchronous Differential Speed Regulator. *S. P. Bartles*

618 Guiding Principles for Use of Horn Gap Air Break and Load Break Switches for Magnetizing and Network Load Currents on Pennsylvania Power and Light Company System. *W. R. Smith*

620 Electrical Features of the Upper Raquette River Power Project. *W. C. Van Dyke*

NEC To Mark 50th Year of Electronics Industry

"Fifty Years of Progress through Electronics" will be the theme of the 12th Annual National Electronics Conference (NEC) in Chicago, Ill., October 1–3.

This year marks the golden anniversary of the electronics industry which was founded in 1906 when Lee De Forest developed the first three-electrode vacuum tube, known as the audion.

Approximately 100 technical papers will be presented and a record 240 commercial exhibits will be featured during this three-day conference which is to be held at the Hotel Sherman, Chicago, Ill.

More than 10,000 persons are expected to attend the meeting—the nation's leading forum on electronic research, development, and application.

The conference is sponsored annually by the AIEE, the Institute of Radio Engineers, the Illinois Institute of Technology, the University of Illinois, and Northwestern University.

Also participating in the conference are Michigan State, Purdue, Michigan, and Wisconsin Universities, as well as the Radio-Electronics-Television Manufacturers Association, and Society of Motion Picture and Television Engineers.

Proceedings of the 1955 National Electronics Conference now can be obtained at $5 per copy from the NEC headquarters, located at 84 East Randolph Street, in Chicago, Ill.

The 1,040-page, cloth-bound book contains the 102 technical papers and three luncheon addresses presented at the 11th annual meeting in Chicago, October 1955.

In addition to the 1955 volume, the following back issues of the NEC Proceedings are available: 1946, 1949, 1950, 1951, 1952, 1953, and 1954.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until August 29. Duplicate double-spaced typewritten copies of each discussion should be sent to Edward C. Day, Assistant Secretary for Technical Papers, American Institute of Electrical Engineers, 33 West 39th Street, New York 18, N. Y., on or before August 29.

56-805 A Field Survey of Transformer Oil Quality. *W. J. Degnan, E. J. Shimanski*

56-269 Applying Industrial Controllers for Safe Operation. *G. W. Heumann*

56-674 Electrical System for a Nuclear Reactor. *E. P. Peabody, D. S. Brereton*

Preprints may be purchased at 40¢ each to members, 80¢ each to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 West 39th Street, New York 18, N. Y.

AIEE PERSONALITIES

B. G. Ballard (AM '33, F '55), vice-president, scientific, of the National Research Council of Canada (NRC), Ottawa, Ont., Canada, and director of its Division of Radio and Electrical Engineering, received the degree of doctor of science from Queen's University, Kingston, Ont. Dr. Ballard was born in 1902 at Fort Stewart, Ont., and graduated from Queen's University in 1924 with a degree in electrical engineering. Following a Westinghouse graduate course in electrical engineering, 1924–25, he joined the staff of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. In 1930, he was appointed to the NRC Division of Physics, and throughout the following 10 years built up the electrical engineering section of that Division. For his wartime efforts, which included the development of mine sweepers and other means of protecting ships against enemy magnetic mines, Dr. Ballard was awarded the Order of the British Empire. In 1946, he was named assistant director of the Division of Physics and Electrical Engineering, and in 1948, a full Division of Radio and Electrical Engineering was established, with Dr. Ballard as director. He was named vice-president, scientific, of the National Research Council in 1954. Dr. Ballard is vice-president of AIEE District No. 10. He is a Fellow of the Institute of Radio Engineers, and a member of the Association of Professional Engineers of the Province of Ontario and of the Professional Institute of the Public Service of Canada. He is also a past president of the Canadian National Committee of the International Electrotechnical Commission. Dr. Ballard has served on the following AIEE Committees. Research (1946–56), and Standards (1953–55).

R. A. Schatzel (AM '28), vice-president and director of engineering, Rome Cable Corporation, Rome, N. Y., has been elected president of the American Society for Testing Materials (ASTM). Born in Kingston, N. Y., Mr. Schatzel received his bachelor of science degree in chemistry from Union College in 1921 and his master's in 1923. On June 10, 1956, Union College conferred on him the honorary degree of doctor of science. Associated with the wire industry since 1924, Mr. Schatzel has distinguished himself in research and development work on electrical cable insulations, particularly rubber and plastics. Named to his present post in 1945, he had previously held top executive positions with the General Cable Corporation and its predecessor, the Rome Wire Company. Mr. Schatzel has written many technical papers, holds numerous patents, and has contributed to various textbooks in his field. He is a Fellow of the American

B. G. Ballard

R. A. Schatzel

COMMITTEE ACTIVITIES

Editor's Note: This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.

NOTE: Because of the changeover in committee personnel, no items appear in this column this month.

Institute of Chemists. His memberships include the American Chemical Society, American Society for Metals, American Association for the Advancement of Science, American Institute of Mining and Metallurgical Engineers, Society of Naval Engineers, Editorial Advisory Board of *India Rubber World*, British Institute of Metals, and British Institute of Rubber Industry and Insulated Power Cable Engineers Association. Mr. Schatzel has served on the AIEE Committee on Insulated Conductors (1947–56).

OBITUARIES

George Edward A. Fairley (M '39) director, Public Safety Department, City of Pittsburgh, Pa., died recently. Mr. Fairley was born in Baltimore, Md., September 23, 1876. He was employed as superintendent for the J. C. M. Lucan Company, Baltimore, Md., from 1900 to 1906. He then became a member of the firm of Penniman and Fairley, consulting engineers, Baltimore, Md. From 1911 to 1917, he was principal assistant engineer for the Electrical Commission of Baltimore, Md. In 1917, he joined the U. S. Army Corps of Engineers as Captain, and was discharged in 1919 with the rank of Lieutenant Colonel. In 1920, be became superintendent of buildings and grounds at the Carnegie Institute of Technology. He was made director of Public Safety for the City of Pittsburgh in 1936. Mr. Fairley was a charter member of the Military Engineers Society.

George H. Roudebush (AM '26), chief engineer, northeastern district, Ohio Bell Telephone Company, Cleveland, Ohio, died recently. He was 58 years old. Mr. Roudebush was born in Carrollton, Ohio, May 26, 1897. From 1916 to 1919, he was engaged in the installation and testing of Central Office telephone equipment for the Western Electric Company. Following this he became an engineer in the division engineer's office of the Cleveland Telephone Company. In 1921, he joined the Ohio Bell Telephone Company. Most of his time with this company was spent in the engineering and traffic departments. In 1944, he was made traffic superintendent in Cleveland, and in 1946, he went to Akron, Ohio, as traffic head for the company's Eastern Division. He became general traffic manager in Cleveland in 1951.

MEMBERSHIP

Recommended for Transfer

The Board of Examiners at its meeting of June 21, 1956, recommended the following applicants for transfer. Any objections to these transfers should be filed at once with the secretary of the Institute. A statement of valid reasons for such objections must be furnished and will be treated as confidential.

To Grade of Member

Angermeyer, L. C., senior electrical engineer, Wagner Electric Corp., St. Louis, Mo.
Appenzeller, J. R., electrical engineer, Bechtel Corp., San Francisco, Calif.
Auer, G. G., application engineer, General Electric Co., Schenectady, N. Y.
Barksdale, W. F., district engineer, Tennessee Valley Authority, Wilson Dam, Ala.
Barracano, H. R., electrical engineer, W. R. Holway & Associates, Tulsa, Okla.
Bloor, W. S., district manager, Leeds & Northrup Co., Atlanta, Ga.
Broache, M. F., supervisory engineer, New York Tel. Co., New York, N. Y.
Burroughs, J. E., application engineer, General Electric Co., Newark, N. J.
Carson, L. H., chief engineer, Woodward-Schumacher Electric Corp., Chicago, Ill.
Cibelius, C. A., Jr., electrical engineer, Barber-Colman Co., Rockford, Ill.
Coffey, G. M., manager, industrial products, Wagner Electric Corp., St. Louis, Mo.
Cundelan, J. V., electrical analytical engineer, M. W. Kellogg Co., New York, N. Y.
Cunningham, C. E., acting supervisor, elec. engg. sec., Baytown Refinery, Humble Oil & Refining Co., Baytown, Tex.
Cunningham, J. H., regional manager, Westinghouse Electric Corp., St. Louis, Mo.
Cutchins, A. P., asst. chief engineer, Mutual Boiler & Machinery Insurance Co., Atlanta, Ga.
DeArcangelis, F. A., switchgear engineer, Westinghouse Electric Corp., Newark, N. J.
Delforge, J. F., electrical engineer, Carbide & Carbon Chemical Co., South Charleston, W. Va.
Donnell, H. P., electrical engineer, Eastman Kodak Co. Rochester, N. Y.
Ebeltoft, W. H., staff engineer, Aero Div., Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Elgerd, O. I., associate professor, elec. engg. dept., University of Florida, Gainesville, Fla.
Ellison, L., Jr., engineer, E. I. du Pont de Nemours & Co., Aiken, S. C.
Ernsberger, W. P., sales engineer, Wiremold Co., Kirkwood, Mo.
Etkin, H. A., technical specialist, Dept. of U. S. Navy, Camden, N. J.
Farr, J. W., electric engineer, General Electric Co., Holyoke, Mass.
Feldman, C., engineer, Allis-Chalmers Mfg. Co., Boston Mass.
Fischer, W. O., laboratory engineer, Simplex Wire & Cable Co., Cambridge, Mass.
Flowers, R. B., application engineer, General Electric Co., Atlanta, Ga.
Fox, J. D., electrical staff engineer, Kaiser Aluminum & Chemical Corp., Spokane, Wash.
Franklin, R. E., field installation engineer, General Electric Co., Newark, N. J.
Gaines, J. M., manager, Brevard District, Duke Power Co., Brevard, N. C.
Gaynor, E., electrical engineer, Radio Corp. of America, Moorestown, N. J.
Gleichauf, P. H., physicist, electronics lab., General Electric Co., Syracuse, N. Y.
Hagaman, H. P., Jr., electrical engineer, Appalachian Electric Power Co., Huntington, W. Va.
Hanpeter, J. A., senior electrical engineer, Sverdrup & Parcel, Inc., St. Louis, Mo.
Hatfield, F. A., engineer, Line Material Co., Zanesville, Ohio.
Hawley, P. F., patent attorney, Stanolind Oil & Gas Co., Tulsa, Okla.
Hedges, M. C., supervising design engineer, Commonwealth Edison Co., Chicago, Ill.
Herrmann, J. E., development group leader, Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Hubbell, H. O., chief engineer, Sulphur Springs Valley Electric Cooperative, Inc., Willcox, Ariz.
Hughes, N. B., Jr., asst. area operating superintendent, Tennessee Valley Authority, Memphis, Tenn.
Jehlicka, L. J., engineer, Commonwealth Edison Co., Chicago, Ill.
Keeler, R. J., research supervisor, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Kirkland, W. N., electrical engineer, Kaiser Steel Co., Fontana, Calif.
Kohan, A., toll studies engineer, Michigan Bell Telephone Co., Detroit, Mich.
Kraft, T. A., budget & application engineer, Ohio Edison Co., Akron, Ohio.
Krishnaswamy, H. O., divisional engineer, Madhya Pradesh Electricity Board, Bilaspur, Madhya Pradesh, India.
Kushner, L. H., chief electric engineer, Victor Gruen, Architects & Engineers, Beverly Hills, Calif.
Lais, L., engineer, Gilbert Associates, Inc., Reading, Pa.
Landyshev, A., elec. engg. associate, University of California, Berkeley, Calif.
Law, S. H., protection engineer, Western Massachusetts Electric Co., Springfield, Mass.
Lessmann, G. P., assistant manager, T&G engg. dept., Westinghouse Electric Corp., East Pittsburgh, Pa.
Limerick, M. D., electrical engineer, Municipal Utility District, Sacramento, Calif.
Love, E. B., master plans branch manager, 11th Naval District, PWO, San Diego, Calif.
Lowe, R. I., Jr., electrical engineer, Cerro de Pasco Corp., La Oroya, Peru.
Madlon, E. A., manager of training, airborne computer labs., International Business Machines Corp., Endicott, N. Y.
Manning, J. V., general manager, Transistor Div., Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Marsh, R. G., assistant professor, Norwich University, Northfield, Vt.
Martin, D. C., consulting engineer, Lyman C. Gross, C.E., 507 Sexton Bldg., Minneapolis, Minn.
McKean, A. L., electrical engineer of cables, Habirshaw Div., Phelps Dodge Copper Products Corp., Yonkers, N. Y.
McKinney, R. L., electrical engineer, Bonneville Power Administration, Seattle, Wash.
McLaren, G. W., sales and application engineer, Allis-Chalmers Mfg. Co., Portland, Ore.
Medal, E. C., engineer, Commonwealth Edison Co., Chicago, Ill.
Mohler, V. E., area operating superintendent, Tennessee Valley Authority, Memphis, Tenn.
Molinski, A. E., supervisor of maintenance, Bethlehem Mines Corp., Johnstown, Pa.
Mooers, H. T., transistor applications engineer, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Moy, G., electrical engineer, Burns & Roe, Inc., New York, N. Y.
Panesar, T. S., electrical engineer, Panesar Electrical Works, Jinja, Uganda, B. E. Africa.
Phinney, J. H., commander, U. S. Coast Guard, Washington, D. C.
Price, W. S., electrical research engineer, American Gas & Electric Co., New York, N. Y.
Reeves, J. H., manager, mfgrg. & repair dept., Westinghouse Electric Corp., Huntington, W. Va.
Rodewald, L. E., division engineer, Minnesota Power & Light Co., Little Falls, Minn.
Salneu, G. C., senior engineer, Philadelphia Electric Co., Philadelphia Pa.
Schmid, R. C., Sales engineer, General Electric Co., Los Angeles, Calif.
Schwager, H. H., manager of engineering, Schwager-Wood Corp., Portland, Ore.
Shainis, M. J., administrative engineer, Mergenthaler Linotype Co., Brooklyn, N. Y.
Singleton, J. L., electrical engineering instructor, U. S. Naval Academy, Annapolis, Md.
Skelly, J. J., technical services engineer, Shell Oil Co., Wood River, Ill.
Stack, W. E., electrical engineer, Sverdrup & Parcel, Inc., St. Louis, Mo.
Swain, R. H., senior electrical engineer, Jackson & Moreland, Inc., Boston, Mass.
Thompson, C. G., central office supervisor, American Tel. & Tel. Co., Sweetwater, Tex.
Trainham, J. G., power director, Philadelphia Electric Co., Philadelphia, Pa.
Tribble, D. D., electrical engineer, U. S. Bureau o Reclamation, Sacramento, Calif.
Trotter, J. D., switchgear engineer, Westinghouse Electric Corp., Chicago, Ill.
Truax, D. E., design engineer, Pennsylvania Transformer Co., Canonsburg, Pa.
van Ravenswaay, R. C., electrical engineer, United Engineers & Constructors, Inc., Philadelphia, Pa.
Wachter, L. J., superintendent, electrical plant, Northern States Power Co., Minneapolis, Minn.
Wagner, C. L., electric utility engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.
Walker, R. C., research associate, electrical engg. dept. University of Michigan, Ann Arbor, Mich.
Walker, V. R., electrical superintendent, Aluminum Co. of America, Point Comfort, Tex.
Waller, M., Major, U. S. Army, Fort Rucker, Ala.
Wallnau, D. W., project engineer, Dictaphone Corp., New Haven, Conn.
Wilson, J. W., senior electro-mechanical engineer, Glenn L. Martin Co., Baltimore, Md.
Woll, H. J., manager, circuit development, Radio Corporation of America, Camden, N. J.
Zembaty, S. A., design engineer, General Electric Co., Pittsfield, Mass.

94 to grade of Member

Applications for Election

Applications for admission or re-election to Institute membership in the grade of Member, have been received from the following candidates, and any member objecting to election should so notify the Secretary before August 25, 1956 or October 25, 1956, if the applicant resides outside of the United States, Canada or Mexico.

To Grade of Member

Boyd, R. B., Tennessee Valley Authority, Chattanooga, Tenn.
Burnett, E. A., Bell Telephone Co. of Pennsylvania, Philadelphia, Pa.
Cassidy, E. F., Stone & Webster Engineering Corp., Boston, Mass.
Frier, C. H. (re-election), Oklahoma Gas & Electric Co., Oklahoma City, Okla.
Hartley, M. S., Sanborn Co., Cambridge, Mass.
Horn, H., Felten & Guilleaume, Koln-Mulheim, Germany.
Ishmael, C. H., Long Beach Naval Shipyard, Long Beach, Calif.
Jackson, R. R., Ohio Bell Telephone Co., Cleveland, Ohio.
Mabbett, A. E., Jr., Metcalf & Eddy Co., Boston, Mass.
Paul, J. W., Convair, San Diego, Calif.
Rodgers, R. W., Westinghouse Broadcasting Co., KDKA-TV, Pittsburgh, Pa.
Rudisuhle, E. J., Lenkurt Electric Co., Inc., San Carlos, Calif.
Spinney, V. L., Allis Chlamers Mfg. Co., Cleveland, Ohio.
Sutton, H. B., Lenkurt Electric Co., San Carlos, Calif.
Thorn, C. B., Jr., Commonwealth Electric Co., Inc., Washington, Ind.
Washburn, C., Engineering Department, City of Jacksonville, Fla.
Woolworth, D. L., Black & Veatch, Kansas City, Mo.

17 to grade of Member

Report of the Board of Directors

THE BOARD OF DIRECTORS of the American Institute of Electrical Engineers presents to the membership its 72nd Annual Report, covering the fiscal year ending April 30, 1956. It contains a brief summary of the principal activities of the Institute during the year, a general balance sheet showing the financial condition of the Institute at the close of the fiscal year, a statement of cash receipts and disbursements, and a schedule of securities owned. Much additional information regarding the activities appeared in various issues of *Electrical Engineering*.

BOARD OF DIRECTORS' MEETINGS

Five meetings of the Board of Directors were held during the year, one in New York, N. Y., and one each in Swampscott, Mass.; Butte, Mont.; Chicago, Ill.; and Dallas, Texas.

Information regarding many of the more important matters which were considered by the Board of Directors appeared in various issues of *Electrical Engineering*.

ANNUAL MEETING

The 71st Annual Business Meeting of the Institute was held in Swampscott, Mass., June 27, 1955. A brief abstract of the Annual Report of the Board of Directors for the fiscal year ended April 30, 1955, was presented by Secretary N. S. Hibshman. Treasurer W. J. Barrett, gave a report on Institute finances.

The report of the Committee of Tellers on the results of the vote on proposed amendments to the Constitution was read by Secretary Hibshman. All proposed amendments were declared adopted.

Mr. Hibshman presented the report of the Committee of Tellers on the vote of the membership for election of officers whose terms were to begin on August 1, 1955. President Monteith presented a President's badge to President-Elect M. D. Hooven who responded by thanking the members for their confidence in him, and gave a brief address on Institute progress.

The Lamme Medal for 1954 was presented to A. M. deBellis, Consolidated Edison Company of New York, Inc., New York, N. Y.

President Monteith gave an address on "Planning for the Future."

GENERAL MEETINGS

Four General Meetings were held during the year, and a brief report on each follows:

Summer General Meeting. The 71st Summer General Meeting was held in Swampscott, Mass., June 27–July 1, 1955, with a registration of 2,320.

There were 50 technical sessions at which 212 papers were presented, a session on color television with four papers, a management session with two papers, a session on safety with four papers, the Annual Meeting, a session at which District prize-winning papers were presented, a Section Delegates conference, a conference of Vice-Presidents and District Secretaries, meeting of the Board of Directors, meetings of many committees, numerous attractive inspection trips, several luncheons with speakers, President's reception and dinner, a dinner-dance, various entertainment events, and many events for the ladies. (*EE, Aug. '55, pp. 700–1*)

Pacific General Meeting. The Pacific General Meeting was held in Butte, Mont., August 15–17, 1955, with an attendance of 252.

The program consisted of a general opening session, 10 technical sessions with 41 papers presented, a Student Branch Counselors luncheon meeting for Districts Nos. 8 and 9, a meeting of the Board of Directors, inspection and sightseeing trips, President's reception and dinner-dance, and many events for the ladies. (*EE, Oct. '55, pp. 929–31*)

Fall General Meeting. The ninth Fall General Meeting was held in Chicago, Ill., October 3–7, 1955, with a registration of 1,693. In 40 sessions, 175 papers were presented. In addition, there was a general session, a session on safety, seven sessions on rotating machinery, and six sessions on various aspects of electrical communication, including two on television and aural broadcasting, a meeting of the Board of Directors, various committee meetings, many inspection trips, a smoker, a National Electronics Conference party, and a varied program for the ladies. (*EE, Dec. '55 pp. 1098–9*)

Winter General Meeting. The Winter General Meeting was held in the Hotel Statler, New York, N. Y., January 30–February 3, 1956, with an all-time record attendance of 5,036.

There were 101 sessions at which 417 papers were presented, a general session; a management session; a session on safety; three sessions on research; two joint sessions —one sponsored by the Committees on Wire Communications, and Transmission and Distribution, and the other organized by the Committees on Television and Aural Broadcasting, and Production and Application of Light; a session on marine transportation; a forum of Technical Committee Chairmen; a meeting of the Board of Directors; Education Committee meeting; various other committee meetings; stag smoker; dinner-dance; many inspection trips; and an elaborate schedule of events for the ladies. (*EE, Apr. '56, pp. 368–76*)

DISTRICT MEETINGS

Middle Eastern District Meeting. A meeting was held in Columbus, Ohio, May 4–6, 1955, with a registration of 706. There were a general session; 23 technical sessions, with 91 papers; a session on management; luncheons; District Student Prize Paper contest; dinner-dance; inspection trips; and ladies events. (*EE, July '55, pp. 608–10*)

South West District Meeting. This District held a meeting in Dallas, Texas, April 2–4, 1956, with a registration of 1,230. The program included 21 sessions at which 64 papers were presented, sessions on aircraft and aircraft applications, power generation, transmission and distribution, communications, management, industry application, District Student Branch Paper Competition, meeting of the Board of Directors, inspection trips, sports, and ladies events. (*EE, June '56, pp. 563–5*)

Great Lakes District Meeting. This meeting was held in Fort Wayne, Ind., April 16–18, 1956. The registration was 607. There were 18 sessions at which 68 papers were presented: a general session, sessions on power, electronics, rotating machinery, inspection trips, dinner-dance, and ladies events. (*EE, June '56, pp. 566–7*)

SPECIAL TECHNICAL CONFERENCES

There were 28 Special Technical Conferences held during the year ending April 30, 1956. Fourteen were jointly sponsored in co-operation with other societies. AIEE sponsorship is by the Technical Committees in co-operation with the local Sections. In the aggregate, 15,706 people attended these Conferences and over 599 papers were presented. Brief summary reports follow.

Aircraft Electrical Applications. This Conference was attended by 425 engineers, including representatives from England, Holland, Germany, Sweden, and Canada. It was held at the Hollywood Roosevelt Hotel in Los Angeles, Calif., October 25–27, 1955. During the 3-day Conference, 23 technical papers were presented covering new ideas and developments in the field. The subject of reliability was stressed both in the papers and the discussions. The technical sessions were divided into three broad subjects: Components and Equipment, Management and Laboratory, and Power Systems for Aircraft. Preprints of individual papers were sold at the Conference. This Conference was sponsored by the Committee on Air Transportation and the Los Angeles Section. No Proceedings were published.

Aircraft and Electric Equipment. A Conference on Aircraft and Electric Equipment was held in conjunction with the South West District Meeting at Dallas, Texas, at the Baker Hotel, for three days from April 2-4, 1956. There were also 60 exhibits of aircraft accessories and electric equipment. For the electrical engineer interested in aircraft there was a complete schedule of technical sessions covering aircraft power generation, transistor applications, protective devices, electronic applications, environmental design, power supplies, feedback

control, and reliability testing. This included 35 technical papers grouped into 8 technical sessions out of a total of 65 papers for the entire meeting. Out of the 35 aircraft papers, 8 were Transactions-type and 17 printed District papers. The remainder were non-numbered papers but many of them were furnished by authors for distribution at the meeting. The individual numbered papers can be obtained at AIEE Headquarters. Approximately 600 aircraft engineers attended. Inspection trips were made to two aircraft plants in the area.

Appliance. Some 175 engineers attended this Sixth Annual Conference at the Hollenden Hotel, Cleveland, Ohio, May 23–25. It was sponsored by the Subcommittee on Domestic Appliances of the Committee on Domestic and Commercial Applications of the AIEE. The Cleveland Section acted as host for the entire time. There were 12 technical papers presented with a panel discussion covering the subject "Trends in Appliance Design" on Monday afternoon, which probably attracted the greatest interest and created the most discussion. No Proceedings were published.

Eastern Joint Computer. This Conference, cosponsored by AIEE, IRE, and ACM (Association for Computing Machinery) was held at the Hotel Statler, Boston, Mass., November 7–9, 1955, and attracted 1,950 engineers and others in the computer field. There were exhibits of manufacturers' equipment and field trips to nearby installations. Fifteen technical papers were presented during the four sessions featuring computers in business, records in electronic accounting systems, system design trends, and intercommunication for computers. The theme of the Conference was "Computers in Business and Industrial Systems" and was slanted towards applications from the point of view of users rather than designers of equipment. Proceedings were published and may be obtained from any of the sponsoring societies.

Western Joint Computer. This Conference was held at the Fairmont Hotel in San Francisco, Calif., February 7–9, 1956, and jointly sponsored by AIEE, IRE, and ACM. There were 38 technical papers presented, and 28 exhibitors participated. There was an attendance of about 1,200 engineers and others. A number of sessions on programming and coding of large-scale scientific and business computers included several papers on automatic programming and supervising systems, emphasizing those techniques which will be helpful in applying computers to business problems.

Novel uses of digital computers as simulators for studying traffic control systems planning new roadways, and baseball forecasting were described.

Among the papers presenting new advances in hardware were descriptions of auxiliary equipment such as magnetic recording heads, the relatively new charactron display tube, new magnetic tape handles, and a system for data transmission over telephone circuits. Proceedings were published and are available from the three sponsoring societies.

Electronic Components. The Sixth National Conference on this subject was held at the Ambassador Hotel, Los Angeles, Calif. on May 26 and 27, with a registration of more than 1,200 electronic engineers and guests. This jointly sponsored Conference by AIEE, IRE, RETMA (Radio-Electronics-Television Manufacturers Association), and WEMA (West Coast Electronics Manufacturers Association) is alternately held on the East and on the West Coasts. A total of 56 technical papers were presented in the 8 technical sessions during the 2-day meeting. A debate took place on May 26th in which four of the nation's leading electronic spokesmen discussed "Tubes versus Transistors." All of the Proceedings were published.

Electronic Material and Components. The Conference on Electronic Material and Components was cosponsored by AIEE and IRE with their respective Sections acting as hosts and taking a very active part in the program. This Conference was held in Philadelphia, Pa., June 2 and 3 at the Penn Sherwood Hotel, as headquarters, with over 300 in attendance. The four technical sessions consisted of a carefully selected and integrated program covering magnetic materials, dielectric materials, insulation materials, and the application of these materials to various types of components. No Proceedings were published.

Industrial Electronics. This Conference was jointly sponsored by AIEE and IRE, and held at the Rackham Memorial Auditorium, Detroit, Mich., September 28 and 29. Eight Transactions-type papers were presented by representatives of each society giving a total of 16 papers for the two days, in the following sessions: Electro-Optical Devices and Applications, Measuring and Recording Instruments and Applications, Process Control and Systems Analysis, and Automation and Machine Tool Control. The Conference was very successful and had an attendance of 200 engineers. Proceedings were published.

National Electronics. Two sessions were organized by the Electronics Committee of AIEE, as one of the cosponsors in the National Electronics Conference. These featured Electronic Circuits and Dielectric Amplifiers. The AIEE papers presented here were authorized for Transactions in the same way as papers in other AIEE Special Technical Conferences. A total of 96 papers were presented which covered a broad field of electronic research, development, and industrial application, with an exhibit consisting of 180 booths. This Conference was held at the Sherman Hotel in Chicago, Ill., October 3–5, 1955, concurrent with the AIEE Fall General Meeting, so that interested members could attend some of the sessions at each meeting. Approximately 10,000 registered at the Conference. All Proceedings were published.

Electric Heating. The second biennial Conference on Electric Heating was held at the LaSalle Hotel, Chicago, Ill., on May 10 and 11, 1955, sponsored by the Committee on Electric Heating and the Chicago Section of AIEE. A total of 280 registered at these sessions. Sixteen papers which covered the industrial heating field were presented and a Proceedings booklet was published.

Instrument-Automation. This Conference was held in co-operation with the ISA (Instrument Society of America) in Los Angeles, Calif., September 12–16 at the Shrine Auditorium. Of the total registration of 14,430, there were 1,248 electrical engineers. AIEE sponsored two technical sessions of three papers each. These were Transactions papers and were put on sale at the time of the Conference. Also on hand at the booth were copies of *Electrical Engineering* and the bimonthly publication on *Communication and Electronics* as well as membership application blanks. The approximately 300 exhibits attracted wide attention and sessions were sometimes neglected.

Magnetic Amplifiers. A Special Technical Conference and Exhibit on Magnetic Amplifiers, cosponsored by the AIEE Committee on Magnetic Amplifiers, IRE Professional Group on Industrial Electronics, and the ISA was held in Syracuse, N. Y., at the Syracuse Hotel on April 5 and 6, 1956. 550 engineers and others attended these meetings. There were 18 technical papers presented; the first technical session was tutorial in nature and consisted of four papers by well-known authors in their respective fields. The other technical sessions covered subjects of material components, theory, and application. The Conference permitted concentration of interest on problems associated with design and applications on magnetic amplifiers, which is now rapidly finding wide applications. Proceedings will be published.

Magnetism. A very successful Conference on Magnetism was held at the William Penn Hotel, Pittsburgh, Pa., June 14–16, inclusive with a total registration of 540, including those in the field of magnetism from basic research through application to devices and ultimate production and testing of commercial magnetic materials. It was jointly sponsored by AIEE, AIME, and APS (American Physical Society). 64 papers were presented which covered both the theoretical aspects of magnetism and its practical applications. There was also an exhibit of items relating to the subject of the Conference. Abstracts of papers were included in the program. All Proceedings were published.

Engineering Management. This Conference was cosponsored by AIEE Committee on Management and the Division on Management of ASME. It was held in St. Louis, Mo., at the Statler Hotel, March 14 and 15, 1956. The theme covered was "Improved Management with and for Engineers" and had an attendance of over 400. The Engineering Management Conferences were begun in 1953 by ASME in Detroit. This year AIEE joined with them, at their invitation, and together provided the forum where engineering managers could meet for the exchange of ideas. The four sessions covered the effective use of engineering skill, development of the engineer as a manager, the engineer's contribution to management, and industry's share in the training of the engineer. In addition to the sessions, a banquet and luncheon were planned with outstanding speakers in this field. Copies of papers

presented were distributed at the meeting. In the future, it is planned to hold these Conferences on Management as a joint endeavor on an annual basis.

Electrical Techniques in Medicine and Biology. The eighth annual Conference on this subject was held at the Shoreham Hotel, Washington, D. C., on November 14–16, 1955, sponsored by AIEE, IRE, and ISA (Instrument Society of America). 15 technical papers were presented during the 4 sessions featuring (1) Angiocardiography, (2) Audiology and Instrumentation for Hearing, (3) New Techniques in Measurements and Recording, and (4) Instrumentation in Medicine and Biology. There was an inspection trip to the National Bureau of Standards, which included a lecture demonstration of instruments developed for physical medicine and biology, and a tour of the following laboratories: Electrical Standards, National Standards of Weights and Measures, High Speed Computer, High Voltage, and Hearing and Noise. The program included abstracts of most of the papers. No Proceedings were published. This Conference provides liaison and better understanding among electronic engineers, medical research, and related fields to advance the development and application of electrical techniques in medicine and biology.

Application of Motors to Space Heating and Cooling. This Conference was held at the Chase Hotel, St. Louis, Mo., October 19 and 20, 1955, with the St. Louis Section acting as host. It was attended by more than 200 representatives of the motor and air-conditioning industries. The Conference was sponsored by the Single-Phase and Fractional Horsepower Subcommittee of the Committee on Rotating Machinery. Sixteen papers were presented and preprints of the papers were available at the Conference. Papers covered ventilating fans, room air conditioners, heat pumps, and warm air heat exchangers.

Nonlinear Control Systems. This Conference was jointly sponsored by the Instruments and Regulators Division of ASME and the Committee on Feedback Control Systems of AIEE, held at the Frick Auditorium of Princeton University, Princeton, N. J., March 26–28 inclusive. 23 technical papers were presented, which included 5 AIEE numbered papers. One of the features was a social hour and banquet at which Dr. F. W. Notestein, Director of the Office of Populations Research in the School of Public and International Affairs at Princeton University, spoke on the subject "The Dynamics of Populations." The papers at this Conference were on basic and new methods for analysis of nonlinear control systems; practical systems with inherent nonlinearities; theoretical and computer studies of so-called optimum relay servomechanisms; and synthesis methods for nonlinear systems. Papers can be obtained on an individual basis or in a package containing all papers from either of the sponsoring societies. Approximately 250 people attended.

Nuclear Engineering and Science Congress. This Congress was sponsored by various technical societies, including AIEE through the Engineers Joint Council and by various Government agencies, in Cleveland, Ohio, at the Public Auditorium, on December 12–16, 1955. 21 papers were submitted under AIEE sponsorship. After eliminations for duplication with others of the 26 participating engineering and scientific societies, AIEE had 13 out of a total of 252 papers on the final program in sessions on Research Reactors and Radiation Laboratories, Instrumentation and Controls for Reactors, Economics in Reactor Design, and Reactor Analysis Techniques of Accellerators. The Congress was believed to be highly successful and plans were being formulated during the Congress for a similar type of meeting in 1956. The AIEE papers presented here may be authorized for Transactions in the same way as papers in other AIEE Special Technical Conferences.

Electrical Engineering as Applied to the Paper and Pulp Industry. The first Conference held on this subject on March 8 and 9, 1956, was attended by 92 engineers and others, at the University of Florida, Gainesville, Fla. It was jointly sponsored by the AIEE Subcommittee on Paper and Pulp, the Jacksonville Section of AIEE, and the College of Engineering of the University of Florida. Eight papers were presented during this 2-day conference all of which were well received. The high point of the meeting was the evening social hour and banquet on Thursday. There were no Proceedings published.

The Petroleum Industry. This Conference took place at the Shamrock Hotel, Houston, Texas, September 12–14. It was sponsored by the Committee on Petroleum Industry of AIEE, with the Houston Section acting as host. 420 engineers from 22 states and Venezuela attended the meeting. One of the highlights of the luncheon was an address by the Vice-President of Westinghouse on the "Outlook for Atomic Power." Twenty-four papers were presented and preprints of most of them were available at the Conference.

American Power Conference. This Conference was sponsored by the Illinois Institute of Technology, in co-operation with AIEE and other local and national engineering societies and universities, and was held at the Sherman Hotel, Chicago, Ill., March 21–23, 1956. The purpose of the sessions was to provide the opportunity for the exchange of information in the field of power generation, transmission, distribution, and utilization. There were 24 technical sessions which covered water technology. There was also a nuclear energy forum. Of the 68 papers presented in these sessions, 19 were contributed by AIEE. An American Power Conference luncheon was held on the second day of the Conference sponsored by AIEE, at which our President, M. D. Hooven, acted as chairman and toastmaster. Cochairman was R. B. Grear of the Chicago Section. The distinguished speaker was Chairman of the Board of Tennessee Valley Authority. This Conference was attended by approximately 2,000. Proceedings were published.

Rubber and Plastics. This Conference, sponsored by the AIEE Rubber and Plastics Industries Subcommittee of the Committee on General Industry Applications, was held at the Mayflower Hotel, Akron, Ohio, April 4–5, 1955, and was attended by 319 electrical engineers and others. The Akron Section acted as host. Eleven technical papers were presented for discussions. The theme was "Automation in the Rubber and Plastics Industries." Proceedings were published.

Scintillation Counter. Some 275 engineers attended this Conference at the Shoreham Hotel, Washington, D. C., February 28–29, 1956, which was sponsored by the AIEE, IRE, NBS, and AEC. There were four daytime sessions covering Photomultipliers and Circuits, Scintillators, Particle Detection and Scintillators, and Special Problems and Techniques. There was also an evening session for the discussion of Scintillation Counter Problems. Abstracts of the papers presented were distributed at the time of the Conference to all who attended.

Simulation. This was a three-day Conference held January 19–21, 1956, at the Baker Hotel, in Dallas, Texas, and was sponsored by the North Texas Section of AIEE, the IRE Dallas-Fort Worth Section, and the Professional Group on Electronic Computers. 35 technical papers were presented and the attendance was 400. The technical papers dealt with equipment, techniques and computer applications in both the mathematical and physical simulation fields. Both analogue and digital aspects were included. All of the Proceedings were published. Tours, in which almost 200 participated, were conducted on the last evening.

Telemetering. A three-day Conference, jointly sponsored by AIEE, IRE, IAS (Institute of Aeronautical Sciences), and ISA (Instrument Society of America) was held in Chicago, Ill., on May 18 to 20 inclusive, and covered subjects on industrial telemetering pick-ups and transducers, flight testing, multiplexing techniques, new developments in telemetering and remote controls, and data processing. On Thursday evening, there was the Annual Banquet and Evening Session in which the Director of the National Advisory Committee for Aeronautics spoke on "Problems in Ultra High Speed Flight." Approximately 473 engineers and others attended. Proceedings were published and were available to all who were present.

Mid-Atlantic Textile. The 1955 Conference at Raleigh, N. C., was the best Textile Conference yet produced. It was held at the North Carolina State College on November 3–4, and 238 attended. Sponsored by the Textile Subcommittee of the Committee on General Industry Applications, eight technical papers were presented. One of the highlights of the meeting was a panel discussion which covered all types of electrical problems and their remedies. A social hour preceded the barbecue dinner on Thursday evening, November 3. Both were well attended. No Proceedings were published.

Southern Textile. The 1956 Conference on Electrical Applications for the Textile Industry was held at the Georgia Institute of Technology, March 1 and 2, 1956. It was sponsored by the Textile Subcommittee of AIEE in co-operation with the A. French Textile School, the Georgia Tech. School of Electrical Engineering, and the Engineering Extension Division. Three papers were presented during the three sessions including a report on "Proposed Recommended Practices for Electrical Installation on Textile Machinery," and a panel discussion on "What Is Your Problem?" The panel was well attended and induced discussions of practical problems concerning textile plant electrical installations and operations. There was a total registration of 175. No Proceedings were published.

Transistor Circuits. 19 technical papers were delivered in addition to the 4 tutorial papers at the 1956 Transistor Circuits Conference held in Philadelphia, Pa., February 16–17, in the Irvine Auditorium and the University Museum Auditorium, under the joint auspices of AIEE, IRE, and the University of Pennsylvania. A total of 1,164 people attended which included many representatives from thirty states, Canada, England, Japan, and Sweden. There were 4 sessions as follows: Special Circuits, Switching Circuits, Small Signal Amplifiers, Power Amplifiers and Power Supplies, and a tutorial session. No Conference Proceedings will be published; however, the printed program contained abstracts for all of the contributed papers.

General Committees

BOARD OF EXAMINERS

The Board of Examiners met every month during the last year except August and acted upon 4,233 applications for admission to or transfer among the grades of membership. This figure is slightly greater than the number acted upon in the previous year—4,210.

The new Constitutional qualifications approved by the membership in 1955 took effect on August 26 and the raising of the qualifications for Associate Member and Member grades might have had some influence in holding down the amount of increase. The new provision of allowing direct admission to Member grade with 13 years' experience as against 10 years for transfer for an Associate Member of 2 years' standing appears to have encouraged direct applications, as two and one-half times as many were admitted directly as were admitted directly during the previous year.

The number of proposals for Fellow grade was about 15 per cent greater than for last year. However this year two were "not recommended" as against none the year before. The Examiners have expended every effort to see that no proposal for Fellow was turned down without a thorough study, and with ample effort to secure from the proposers all possible information that might justify approval. As has been noted before, the problem with Fellow proposals is to find some work that rates sufficiently above what would be called good engineering practice to justify distinction.

A difficult problem sometimes arises in handling the transfer of members from foreign countries. It involves credits allowed in the Constitution for memberships in foreign societies having qualifications equivalent to those for our own grades. Most foreign societies do not have various membership grades as do American societies. The Board of Examiners has asked the Board of Directors to be allowed to evaluate honors, and officer positions in foreign societies insofar as the qualifications leading to those honors or offices can be ascertained, and substitute them for the missing grades involved. The Board of Directors has given such permission.

During the past year, the Board has studied the problems involved in the advancement of qualified engineers in sales departments to Member grade. It is believed some progress has been made toward outlining instructions that should assist in passing upon applications therefrom.

The Board has given considerable study to the subject of credit toward professional experience that might be given to graduates of nonaccredited curricula, and to the holders of advanced degrees in science, mathematics, and engineering in the case of applicants for Associate Member and Member grades. The ECPD had mentioned that credits might be given, but had made no suggestion as to how to evaluate the education. The Board is progressing cautiously in this respect, and up to the present has proposed using certain criteria from an applicant's experience that appeared indicative of ability and adequate training. The Board of Directors at its meeting on February 2, 1956, approved their proposals which were reported in the March issue and published in the June issue of *Electrical Engineering*.

Table I. Applications and Proposals Received by the Board of Examiners May 1955 to April 1956

Admission			
Affiliate			
Recommended	300		
Not Recommended	2		302
Associate Member			
Recommended	2,670		
Re-elected	147		
Not Recommended	71		2,888
Member			
Recommended	160		
Re-elected	7		
Not Recommended	13		180
Total Admission Cases			3,370
Transfers			
Fellow			
Recommended	46		
Not Recommended	2		48
Member			
Recommended	765		
Not Recommended	33		798
Associate Member			
Recommended	15		
Not Recommended	2		17
Total Transfer Cases			863
Total Applications			4,233
Student Affiliate Enrollment			376
Student Member Enrollment			4,810
Grand Total			9,419

The Examiners have recommended that Chairmen of Institute Standing Committees and of Sections be credited with responsible charge of important engineering work for their time spent as chairmen in applications for Member grade. Heretofore, services of these kinds have been given no recognition. The Board of Directors approved this credit in February.

The Examiners have assisted the Committee on Constitution and Bylaws in preparing a Bylaw authorizing the recognition of an approved license as Professional Engineer as evidence that the holder thereof had had professional experience acceptable toward Member and Associate Member grades. The new Bylaw, approved by the Board of Directors was carefully drawn to avoid the possibility of counting twice the experience upon which the professional license was based.

Assistance has been given the Transfers Committee in revising the leaflet "Guide to Transfers in Membership." Suggestions were made as to changes in the present material, and full information was supplied on the new credits for applicants for education and Institute Committee and Section service that was approved by the Board of Directors in February.

An article has been published in the June 1956 issue of *Electrical Engineering* on the Constitutional changes of 1955, and the new credits mentioned approved by the Board of Directors.

A subcommittee has been appointed to study the present Institute application blanks and make recommendations on revising them.

The Board is revising its Code of Practice to include fuller information on newer instructions and interpretations with respect to evaluating the experience and education of applicants.

COMMITTEE ON CODE OF PRINCIPLES OF PROFESSIONAL CONDUCT

The committee sponsored conferences on ethics at the Summer General Meeting of AIEE in Swampscott, Mass., in June; at the Winter General Meeting in New York, N.Y., in January 1956; and at the Rochester (N. Y.) District Meeting in May. Three meetings of the committee were held; and, in addition, three members of the committee attended the meeting of the ECPD Committee on Ethics in Toronto, Ont., Canada, in October 1955.

Out of discussions at the Summer General Meeting, members of the committee developed a strong conviction that any considerable advance in the application of the principles of professional conduct by our AIEE members, and especially any improvement in the teaching of ethics in engineering schools, must come from the discussion of specific cases that will bring professional ethics from the realms of abstract philosophy and generalities down to the realistic considerations of daily life. It is, therefore, the committee's view that the responsibility of the professional societies in regard to ethics does not end with the writing and adoption of a code of highly moral principles. The societies have a continuing duty to stimulate their members to apply the Code of Ethics in their daily professional lives.

The January conference in New York took the form of a panel discussion, with

audience participation. An opinion meter was used to measure the audience's response to several questions that were posed, to determine the consensus as to the proper ethical procedure in specific cases. It is intended, on the basis of the experience to be gained, to develop a series of future conferences dealing with specific ethical problems; and, in this way, to arouse greater interest and participation in the consideration of ethics by Institute members generally.

As a result of discussions in the committee and at the ECPD meeting in Toronto, it is proposed that six supplements to the "Canons of Ethics" be prepared by appropriate engineering groups, preferably under ECPD sponsorship. These suggested supplements are:

1. Ethics for Employers of Engineers (*Supplementing Numbers 21 and 22 of the Canons*). This should emphasize the truth that the engineer has a personal responsibility for his professional work, which cannot be delegated to others; it should make clear the distinction between the work of the engineer and of the technician. Also, the duty of employers to provide opportunities for each engineer to extend his education and to contribute to professional society activities should be made clear.

2. Ethics for Engineers Who Work for More Than One Employer (*Supplementing Numbers 15 and 27 of the Canons*). The duty of the employed engineer to obtain the consent of his employer before undertaking work for another should be emphasized. Also, the engineer's obligation to give full measure of services to each employer or client, beyond the mere devotion of a specified time to the work, should be fully developed. This subject is important because of the large number of employed engineers who have "week end" jobs also, and because of the many engineers who divide their time between two or more employers.

3. Ethics of Recruiting. This supplement may well be based on the pamphlet recently prepared by the American Society for Engineering Education (ASEE) on this topic. It should give special consideration to the procedures in recruiting college students, and to the practice known as "pirating" of already employed engineers. The proper procedure for an employed engineer in seeking a new position should also be developed.

4. Ethics for Engineering Students. This may well be based on the excellent pamphlet, *Engineering—A Discipline*, that has been used for some time in the Newark College of Engineering. It should give special consideration to the honor system in homework and examinations. It also should make clear the responsibilities of students to their teachers and to the educational insitution.

5. Ethics for Licensed Professional Engineers, (*Supplementing Numbers 4, 11, 12, 17, and 28 of the Canons*). This supplement should provide a specialized code of ethics that may be used by licensing boards in deciding whether to grant or to withdraw licenses. It should be so phrased that the ethical requirements set forth may be legally enforceable, and that ultimately it may form a supplement to the Model Licensing Law.

6. Ethics for Engineering Organizations. This supplement should make clear the duty of the engineer to put the interests of the public before personal gain, and should outline what are fair and proper procedures for engineering organizations in their relations with employers, other similar organizations, and the public.

Pending decisions that may be reached by the ECPD committee next fall, it is proposed to hold additional conferences at the Rochester, San Francisco, Chicago, and other AIEE Meetings at which specific ethical problems will be considered. It is hoped that these conferences will provide interesting articles for publication in *Electrical Engineering*, and material that will be helpful in the teaching of ethics in engineering schools.

COMMITTEE ON CONSTITUTION AND BYLAWS

The year under review has been active and constructive. The amendments introduced have been designed to clarify and simplify, as well as to broaden the statutes of the Institute. The activities of the Institute have become so enlarged and varied that the Constitution and Bylaws need to be overhauled and regarded not so much as a rule book, but a book of statutes which give legal basis for those regulatory measures required by the operational units and divisions of the Institute. Thus, the trend is to delete detail matters from the Constitution in particular, which involves costly procedure in order to amend them by membership vote.

With this in view, the Committee has studied a new format and a new decimal numbering system which was submitted to the Board of Directors at their meeting in Dallas, Texas, April 3, 1956. Their approval was unanimous and carried with it the mandate to proceed with this program for rewriting the Constitution and Bylaws in their entirety. The new style is patterned after that of the "Standard Handbook for Electrical Engineers" where each paragraph is prefaced in bold face letters with the subject matter thereof. This is the new look for the Constitution and Bylaws in the making.

Some of the highlight revisions and additions for the year are as follows:

(1) Amendments were made and approved to permit partial educational and experience credits to worthy applicants of this type, as requested by the Board of Examiners.

(2) Provision was made in the Bylaws to permit exhibits at our General Meetings, which heretofore was prohibited.

(3) At the request of the Sections Committee, amendments were made to make the incoming Section Chairman or newly elected Chairman the preferred delegate at the Section Delegates Conference held annually at the Summer General Meeting.

(4) Amendments were made to facilitate the admission of qualified students upon graduation.

(5) Amendments were made to forward to each Section their monetary allotment in one payment instead of two as heretofore, and without any deduction for any unspent balance.

(6) An important addition was made to the Constitution and Bylaws to authorize the establishment of Overseas Chapters.

(7) Amendments were made to improve the balloting and speed the counting of the returned ballots at our annual elections.

(8) The voting privileges of Affiliates have been specifically defined.

(9) Waiver of entrance fees to the IEE has been implemented in the Constitution and Bylaws.

(10) All statutes pertaining to Students and Student Branches are being rewritten and regrouped with the previously mentioned new style for the next publication of the Student Manual.

COMMITTEE ON EDUCATION

The Committee on Education held two meetings during the year, one at the Fall General Meeting in Chicago and one at the Winter General Meeting in New York. The Committee sponsored two sessions and co-sponsored two others at these same two general meetings.

In co-operation with the Committee on Management, a four-paper session was staged in Chicago on the subject: "The Improved Utilization of Engineers and Technicians." The first two papers described the relative preparation of engineers and technicians, as well as their intended roles in industry. The second two papers delved into the management problem of determining optimum utilization of such technical personnel, along with case examples of effective utilization.

At the Winter General Meeting the Committee sponsored two sessions, one on co-operative education and the other on new curricula in engineering education. Both sessions were intended to be informational to members of the Institute to bring them up to date on current practices. In addition, new plans and new ideas for the future were presented for the purpose of obtaining membership reaction.

The Committee also cosponsored a session with the Committee on Research which dealt with the general problem of research in the electric power industry as a means of attracting high-level electrical engineering graduates toward careers in the power field.

The Committee feels that one of its big jobs is to determine the educational requirements for the graduate electrical engineer who is to become a successful practicing engineer. Since these requirements are changing rapidly, it is important that the electrical engineering curriculum be sufficiently fundamental to permit graduates to adapt themselves to the changing times. The process of evaluating industry requirements in relation to educational programs must be a continuous one. The Committee has already planned future sessions to explore additional facets of this over-all problem.

FINANCE COMMITTEE

The Institute has completed a full year's experience with higher dues and the results are very gratifying. Our income has exceeded expectations and is now appreciably in excess of expenses. This has reversed the trend of the past two years. It was anticipated that resignations would increase during this past fiscal year due to the increased dues. It has been encouraging that the resignations were below our estimates.

The 1956–57 budget approved by the Board of Directors at the April meeting has been rearranged to show more directly the income and expense allocated to specific functions. This has been done to permit a more accurate economic analysis of our functions to develop further economies and

improvements in income and in operations.

The Finance Committee in co-operation with the Headquarters Staff has continued efforts to simplify office routines, adopt more modern methods and equipment, and to eliminate nonessential items. Section allotments will be paid annually instead of semi-annually. The exchange allowance to foreign members instituted during the depression has been discontinued at an appreciable saving. Our practice in this matter is now consistent with that of the other major societies. Membership cards have been redesigned and will be issued with the 1956 dues bills. This will eliminate the need for a special card mailing when dues are paid. Recommendations have been made to the Board that effective in 1957 *Electrical Engineering* be mailed for three months and members be continued in good standing for six months instead of a full year pending payment of current dues.

COMMITTEE ON MANAGEMENT

The Committee on Management sponsored a session at each of the General Meetings. Interest in the sessions has continued at a high level with excellent attendance. Committee meetings were scheduled during the Summer, Fall, and Winter General Meetings. At the Summer General Meeting, a representative of the Committee on Management addressed the Section Delegates in order to stimulate more interest by the Sections in holding management sessions or management discussion groups. A number of the delegates indicated that this activity would be promoted more vigorously at the Section level.

A two-day meeting in St. Louis was co-sponsored by the American Society of Mechanical Engineers Management Division and the Committee on Management. An excellent program was presented at this meeting which was well attended by Institute members. It is expected that this joint activity will be continued in future years. The 1957 meeting is scheduled in Pittsburgh, Pa., next March.

A set of objectives was prepared for guidance of the Committee on Management. Subcommittees are actively working on the promotion of management subjects at Section meetings, the expansion of joint activities with other Institute committees, and the preparation of programs for future meetings. Arrangements have already been made with the Committee on Student Branches for a joint session at the Fall General Meeting.

COMMITTEE ON MEMBERS-FOR-LIFE FUND

Since submitting its last report to the Board, the Committee has held two meetings, one at the Summer General Meeting in Swampscott and the other at the Winter General Meeting in New York. In its report of a year ago, the Committee pointed out that the fund increases a significant amount each year and that the present practice of defraying the expenses to the Summer General Meeting for the prize winners of the Student District Technical Paper competitions uses less than half of the annual accumulation of the fund. The capital value of the fund as of May 1, 1955, was $20,698.90; the income from investments, $181.25; contributions from J. M. Golding, $80.00; less traveling expenses of student branch prize winners, $2,384.80 and $19.97 for stationery, leaving a balance as of March 31, 1956 of $18,555.38.

In its last report, the Committee also stated that it had voted to recommend the establishment of a new Institute Medal to be awarded in the field of electrical engineering education. The Board has given its approval to this recommendation as well as to the by-laws governing the award of the new Medal. The Medal and the certificate, which is to accompany it are being designed, under the supervision of the Committee, by companies which specialize in this type of work. The Medal is to be of gold and the same size as the Edison and Lamme Medals. A watch-charm replica of the Medal will also be included in the award. The Medal will be known for the present as an "American Institute of Electrical Engineers Medal in Electrical Engineering Education Provided by the Members-for-Life Fund." The first award is to be made at the Fall General Meeting in Chicago, October 1–5. The Committee is pleased to report that a substantial number of nominations has been received to date.

The Committee feels that a large proportion of the accumulation of the fund should be devoted to student activities and has requested the Committee on Student Branches to make recommendations as to specific uses of the fund for student purposes. The latter Committee has recommended that the practice of defraying the traveling expenses to the Summer General Meeting of the student winning the prize-paper contest from each District be continued. Three additional projects which the fund might sponsor have also been recommended by the Committee on Student Branches, and these will be considered sympathetically at the next meeting of our Committee on Members-for-Life Fund.

MEMBERSHIP COMMITTEE

Membership in the Institute reached a new high of 49,949 members as of April 30, 1956. This is an increase of 956 members over a similar figure of a year ago or a gain of 2 per cent.

Table II shows the distribution and the net changes among the various grades of membership. This tabulation also reflects various changes in membership as a result of the $5 increase in dues which became effective May 1, 1955. The resignations increased to 1,014 from 474 as of last year and the members dropped due to nonpayment of dues increased to 1,455 from 1,071 last year. Total deductions in membership totals were 5.5 per cent as compared with 3.7 per cent a year ago. When the increase in dues was first discussed it was estimated that the loss in membership might be as high as 10 per cent. It is interesting to note that 430 former members were either reinstated or re-elected which is the largest numerical gain on record for former members.

Table III indicates that during the year 3,912 applications were received of which 1,699 were from students and 2,213 from others. Now that the Student member totals are on the increase, the applications from students are also on the increase thus marking the end of the decline in applications received from students, experienced since 1951. Likewise the gradual decline in total applications received since 1950 has been checked with an increase of 323 applications received over last year's total.

Student membership, as shown on Table IV, continued to increase from 6,904 in 1954, 7,666 in 1955 to 9,076 this year. In addition, there are 382 new Student Affiliate members. The hard work and continued efforts of the Committee on Student Branches in encouraging students to become Student members are responsible for these increases.

Members in arrears for dues numbered 3,090, or 6.2 per cent; this is an increase over last year when 1,961, or 4.0 per cent, were delinquent. This increase in delinquent members was expected following the recent increase in dues.

The "Membership Information" folder was revised and several Membership Committee aids were distributed to the Sections during the year.

The committee is especially appreciative of the co-operation and sincere efforts of the Student Branch Counselors, the members of the Section Membership Committees, and

Table II. Membership Statistics for Fiscal Year Ending April 30, 1956

	Honorary Members	Fellows	Members	6-Year Associate Members	Associate Members	Affiliates	Sub-totals	Totals
Membership April 30, 1955	5	1,521	11,353	14,970	20,211	933		48,993
Additions:								
New members qualified			102		2,827	294	3,223	
Former members reinstated or re-elected			65	171	189	5	430	
Subtotals			167	171	3,016	299	3,653	
Transfers	2	35	748	4,058	7		4,850	
Totals	2	35	915	4,229	3,023	299	8,503	
Deductions:								
Died		23	97	84	23	1	228	
Resigned		8	131	478	383	14	1,014	
Dropped		4	117	528	769	37	1,455	
Subtotals		35	345	1,090	1,175	52	2,697	
Transfers		2	35	624	4,182	7	4,850	
Totals		37	380	1,714	5,357	59	7,547	
Net Changes	2	−2	535	2,515	−2,334	240	956	
Membership April 30, 1956	7	1,519	11,888	17,485	17,877	1,173		49,949

Table III. Number of Applications Received from Student Members and from All Others

Year Ending April 30	Students	All Others	Total
1943	783	1,431	2,214
1944	466	1,908	2,374
1945	249	2,179	2,428
1946	308	2,453	2,761
1947	938	2,331	3,269
1948	1,481	2,272	3,753
1949	2,286	2,192	4,478
1950	4,033	2,417	6,450
1951	4,168	2,082	6,250
1952	2,591	2,430	5,021
1953	1,614	2,405	4,019
1954	1,157	2,547	3,704
1955	1,045	2,544	3,589
1956	1,699	2,213	3,912

Table IV. Number of Students

Year Ending April 30	Student Members: New Applicants	Student Members: Renewals	Student Affiliates	Total
1943	2,512	3,200		5,712
1944	2,242	2,656		4,898
1945	2,326	2,287		4,613
1946	2,574	2,513		5,087
1947	5,092	3,929		9,021
1948	7,876	6,041		13,917
1949	9,967	9,461		19,428
1950	7,876	12,792		20,668
1951	4,635	10,393		15,028
1952	3,023	5,834		8,857
1953	2,744	4,038		6,782
1954	3,571	3,333		6,904
1955	3,832	3,834		7,666
1956	4,888	4,188	382	9,458

their chairmen for this continued healthy growth of membership in the Institute.

COMMITTEE ON PLANNING AND CO-ORDINATION

During the administrative year, 5 meetings of the Committee were scheduled: Chicago, Ill., October 4, 1955; New York, N. Y., January 31, March 15, and May 22, 1956; and San Francisco, June 27, 1956.

The work of the Committee has been conducted under numbered "assignments," reported upon in sequence in the following paragraphs. Omission of a number indicates a completed assignment.

1. General and District Meeting Schedules. Under this assignment, the Committee has attempted to develop an orderly long-range program of Institute meetings, correlated with those of other engineering societies. A set of policies governing General and District Meetings was drawn up (*EE, Sept. '55, p. 851*) and the meeting schedule expanded to a 5-year-in-advance basis. Copies of the 5-year schedule have been sent to other major engineering associations.

The authorized current schedule of future General and District Meetings is appended. Recommendations were made for the Summer General Meeting beyond 1961, but the Directors declined to approve meetings more than 5 years in the future.

2. Redistricting of the Institute. Under the plan of local option reported last year, Districts 1 and 4 are considering self-division.

The Committee recommended and the Directors approved changing the name of District 3 from "New York City" to "Metropolitan New York." The suggestion was made by the District's Vice-President and deemed appropriate since parts of the States of New York and New Jersey, in addition to New York City proper, are included in the District 3 territory.

3. Questionnaire on Employment Conditions. A second article giving results of the questionnaire was published (*EE, Sept. '55, p.* 759). Entitled "Comparison of Answers by Supervisors and Nonsupervisors," it presented a summary of replies to 5 questions which permitted such analysis.

7. Ballot for Institute Officers. The Committee recommended changes in the election procedure to eliminate the written ballot in the case of no contest. The Directors declined to approve this recommendation.

The Committee recommended, and the Directors approved, amendment of the Constitution and Bylaws so that eventually the following schedule will govern the election of officers:

February 15 is last date for Nominating Committee meeting
March 15 is last date for receiving petitions
April 15 is last date for mailing ballots

The Directors also approved simplification of the procedure to be followed by the Committee of Tellers, as recommended by the Committee.

8. Organization and Finance. Stevenson, Jordan and Harrison, Inc., engaged to study the Institute's present organization and recommended improvements where indicated, submitted three reports:

(1) Letter report on meetings and publications.
(2) Review of Organization with Conclusions and Recommendations, March 1956.
(3) Review of Activities with Conclusions and Suggestions, March 1956.

These reports are under consideration by the Committee and the Board of Directors.

9. Membership Opinion Research. A detailed report of the survey conducted by Opinion Research Corp., Princeton, N. J., was issued to the Board of Directors and distributed to interested committees. Interviewers called on 203 members, representing a cross section of the membership by grade and District, and sought their opinions of present Institute services and policies. A summary of results was published in an article entitled "Members Appraise the AIEE," by H. L. Rusch and W. D. Rugg (*EE, Jan. '56, pp 60–4*).

A second survey is under consideration to provide guidance in the development of the Institute's technical activities.

10. Annual Electrical Exhibit. For the guidance of meeting committees, the Committee reviewed Institute policy toward sponsorship of electrical exhibits. Legal aspects and practices of other societies were explored. The Committee recommended that changes be made in the Bylaws to remove restrictions interpreted to prohibit holding exhibits in conjunction with General Meetings, either under Institute management, or sponsorship with proper control. The Directors approved the repeal of Bylaw 34 (1955 edition), thereby permitting exhibits.

Table V. Record of AIEE Membership Totals as of May 1

1884	71	1909	6,400	1933	17,010
1885	209	1910	6,681	1934	15,230
1886	250	1911	7,117	1935	14,269
1887	314	1912	7,459	1936	14,600
1889	333	1913	7,654	1937	14,600
1890	427	1914	7,876	1938	16,078
1891	541	1915	8,054	1939	16,605
1892	615	1916	8,202	1940	17,213
1893	673	1917	8,710	1941	17,886
1894	800	1918	9,282	1942	18,944
1895	944	1919	10,353	1943	20,161
1896	1,035	1920	11,345	1944	21,407
1897	1,073	1921	13,215	1945	23,072
1898	1,098	1922	14,263	1946	25,090
1899	1,133	1923	15,298	1947	26,470
1900	1,183	1924	16,455	1948	28,408
1901	1,260	1925	17,319	1949	30,791
1902	1,549	1926	18,158	1950	34,198
1903	2,229	1927	18,344	1951	38,058
1904	3,027	1928	18,265	1952	42,220
1905	3,460	1929	18,133	1953	45,426
1906	3,870	1930	18,003	1954	47,923
1907	4,521	1931	18,334	1955	48,993
1908	5,674	1932	18,003	1956	49,949

12. Registration Fees. The Planning and Co-ordination and the Finance Committees, in accordance with an assignment from the Board of Directors, investigated the desirability of raising the registration fees at all of the Institute's meetings. The following rate schedule was evolved and approved by the Directors, effective January 1, 1956.

Meetings	*Members*	*Nonmembers*
General	$5	$8
District	$3	$5

The Committee presently has under discussion reduced fees for partial attendance.

13. Entrance Fees. As instructed by the Board of Directors, the Committee studied the possibility of eliminating entrance fees, completely or conditionally. Such a move was found to be undesirable at present because of financial considerations.

14. Foreign Sections. The Committee recommended and the Directors approved

creation of a new self-supporting unit, Overseas Chapter, for organization outside the United States, its Territories and Possessions, the Dominion of Canada, and Mexico. A Chapter may be formed upon petition of 10 members, and will be administered by District 3.

Schedule of Approved Meetings.

1956
- Fall General, Morrison Hotel, Chicago, Ill., October 1–5

1957
- Winter General, Hotel Statler, New York, N. Y., January 21–25
- Southern District (4), Jackson, Miss., April 3–5
- Great Lakes District (5), Des Moines, Iowa, April 15–17
- North Eastern District (1), Pittsfield, Mass., May 1–3
- Middle Eastern District (2), Dayton, Ohio, May 7–9
- Summer General, Montreal, Que., Canada, June 24–28
- Pacific General, Yakima, Wash., August 28–30
- Fall General, Chicago, Ill., October 7–11

1958
- Winter General, New York, N. Y., January 20–24
- Middle Eastern District (2), Washington, D. C., April or May (tentative)
- Great Lakes District (5), E. Lansing, Mich., May (tentative)
- Summer General, Buffalo, N. Y., June 23–27
- Pacific General, Sacramento, Calif., August 19–22
- Fall General, Pittsburgh, Pa., October 27–31

1959
- Winter General, New York, N. Y., January 19–24
- Southern District (4), Atlanta, Ga., April 8–10 (tentative)
- Middle Eastern District (2), Baltimore, Md., May 19–21 (tentative)
- Summer and Pacific General, Seattle, Wash., June 22–26
- Fall General, Chicago, Ill., October 12–16

1960
- Winter General, New York, N. Y., February 1–5
- Summer General, Atlantic City, N. J., June 20–24
- Pacific General, San Diego, Calif., August (tentative)
- Fall General, Chicago, Ill., October 10–14

1961
- Winter General, New York, N. Y., January 30–February 3
- Middle Eastern District (2), Pittsburgh, Pa., May 2–4 (tentative)
- Summer General, Ithaca, N. Y., June 19–23

COMMITTEE ON PRIZE AWARDS

Seeking new channels for recognition of achievements of Institute members has been the major activity of the Committee on Prize Awards this year. As a result of study, investigation, and collaboration with the Technical and General Committees, recommendations have been made to the Board of Directors for the creation of five new medals for outstanding achievement in the fields of: (1) Communication, (2) Industry and Transportation, (3) Electrical Power, (4) Electronics, and (5) Electricity and Magnetism.

These new medals have been approved in principle, and a program is under way for implementing them.

A review of past practices in the awarding of District Prizes has shown divergence of objectives and resultant weakening of these Awards. Following a canvass of District Vice-Presidents, a uniform policy has been formulated which places greater emphasis on recognition of achievement by District members.

The quality of "originality" as a contributing factor in the selection of student papers for Institute Awards has been explored in co-operation with the Committee on Student Branches. The agreed solution to the problem is a definition of "originality" to be incorporated in the rules.

Revised rules for awarding of paper prizes have been prepared and will be offered to the Board of Directors before the close of the administrative year. These will implement changes decided by the Committee during the past two years.

The Division and Student Prizes for the 1954–55 administrative year were presented at the 1956 Winter General Meeting, and these are listed in the April 1956 *Electrical Engineering*. For the first time, the names of winners were included in the final printed program of the Winter General Meeting. Another innovation was the inclusion of a brief citation in the announcement of each prize paper, indicating the nature of its achievement.

COMMITTEE ON PUBLIC RELATIONS

This has been a year of transition during which the Institute's Public Relations (PR) program has moved to broader horizons. An accelerated program with much wider objectives than heretofore is now under way. The program is being extended into areas where PR previously had not been emphasized.

Recognizing the role of public relations in the growth and welfare of the Institute, President A. C. Monteith in 1955 appointed an Ad Hoc Committee to survey the public relations activities of the Institute.

This committee was composed of F. S. Black, chairman; H. C. McDaniel, and K. G. Patrick.

After prolonged study, the committee reported that, in general, the Institute was moving in the right direction, public relations-wise. The committee made six recommendations: that the Board of Directors state its PR objectives in writing; that a long-range program be inaugurated; that appropriations for PR be increased; that the Institute continue the services of PR counsel; that the functions of the Public Relations Committee be spelled out in the Bylaws, and that the Public Relations Committee Chairman be a top AIEE policy officer.

The Board of Directors has seen fit to implement several of these recommendations. At its meeting in Dallas, it approved a budget that calls for a broadened internal and external program aimed at objectives outlined by the Ad Hoc Committee, to accelerate PR activities in the Sections to help increase membership and attendance at meetings; to provide additional tools for securing more publicity; to provide up-to-date literature for use of Sections, the Institute, and Committees; to provide literature on electrical engineering for high school students and college students; to accelerate publicity for General and District Meetings, and to step up PR activities aimed at the general public.

It is a pleasure to report that the vast majority of the Institute's 109 Sections in the United States, Canada, and Mexico now have active Public Relations Committees which are concerned with enhancing the prestige of the Sections, their members, the Profession, and the Institute. A few years ago, before the Institute recognized the importance of PR, publicity or public relations committees at the Section level existed largely on paper. Today the Sections are going along with the Institute in a vigorous PR program.

It is gratifying to note the interest in public relations of the Sections, as evinced by those that have inaugurated periodic news letters to keep their members up to date on Section events and programs; those that are making use of newspapers, radios, and television; the increased effort to make meeting notices and bulletins more attractive and eye-catching; and the awakening of interest in Section news events in *Electrical Engineering*.

It is good also to see the real interest and enthusiasm of publicity committees of General and District Meetings. Without exception, these committees have produced splendid publicity results in their local newspapers, radio, and television stations.

The Committee's PR Counsel has worked successfully with these local groups, furnishing advance publicity material and giving on-the-spot assistance at such meetings as the Middle Eastern District Meeting in Columbus, Ohio, the Summer General Meeting at Swampscott, Mass., the Fall General Meeting at Chicago, Ill., the Southwest District Meeting at Dallas, Texas, and rendering assistance for the Southern District Meeting at St. Petersburg, Fla., and the Pacific General Meeting at Butte, Mont., and for many Special Technical Conferences. This activity also has promulgated knowledge of and interest in the Institute's program on behalf of the membership. Counsel also was charged, as usual, with the many details of the PR program for the Winter General Meeting in New York, N. Y.

During the past year the PR program which the Institute has been following has been pursued diligently with gratifying results. The 1955–56 program has utilized such public relations tools as the Publicity News Letter, radio scripts, the Publicity Kit, and other aids to the Sections; Institute news stories and articles about appointments, election of Fellows, election of officers, special events such as the presentation of the Marconi Bust, formation of new Sections and Subsections, policy changes, etc.; aggressive but dignified publicity before, during, and after General and District Meetings and Special Technical Conferences. All public information media has been utilized—daily and weekly newspapers the industrial and scientific trade press, radio, and television. It can be said fairly that the Profession and the Institute have recorded a new high in public recognition during the past year. New records in attendance at General and District Meetings,

record membership in the Institute and the increased number of electrical engineering students, may or may not reflect this PR activity, but it certainly was a factor.

One result of this leavening of activity in public relations has been the inauguration of PR workshops at General Meetings. The first was held during a Section Delegates meeting at the Winter General Meeting in New York last February. This was attended by some 150 persons interested in this activity. It was evident that Institute leadership in Public Relations is being reflected throughout the Society. At this writing a second Workshop, modeled after the Winter one is scheduled for the Summer and Pacific General Meeting in San Francisco. It is hoped that this type of activity can be continued and perhaps be extended to District Meetings.

In conclusion, the Committee feels that the past year has witnessed definite progress in carrying out the Institute's PR objectives. But it realizes that it cannot, in a short space of time, overcome the inertia of almost three quarters of a century. It can only hope that now, with clarification of the Institute's PR objectives, it can with hard work and the continued co-operation of members of the Society and headquarters staff fix favorable public attention on the contributions of electrical engineering to our civilization, so that the individual electrical engineer and the Profession can enjoy the recognition they so richly deserve.

PUBLICATION COMMITTEE

The entire range of Institute publications has been studied in the light of the survey, "Members Appraise the AIEE," made by Opinion Research Corporation. The survey indicated a demand for more general interest material, the need for increasing the electronics and communications subject matter, and the fact that the bimonthly publications were not well known.

Electrical Engineering. The editorial policy to publish articles of broad general interest for a great many members and one-page digests of technical papers has been continued. The cover, title, and highlights pages have been redesigned to provide for a listing of feature articles and a more modern appearance. The number of electronics and communications articles has been increased as well as the number of general articles. The distribution of the 1,236 editorial pages in the 12 issues is shown in Fig. 1. Five per cent of the general articles, 44 per cent of the technical articles, and 24 per cent of the one-page digests were electronics subject matter. Using the primary interests of members as expressed in the 1951 technical questionnaire surveys as a yardstick, Table VI shows a comparison of subject matter that has appeared in the magazine in recent years.

A readership survey of *Electrical Engineering* is being sent to 1,000 different members each month in proportion to the geographical location of the membership. Valuable data have been obtained in respect to the relative order of preference for feature articles as well as the different departments in the magazine. Provision also is made to suggest subjects for future articles and the answers to other questions have yielded important product information and data indicative of the value of the publication as an advertising medium.

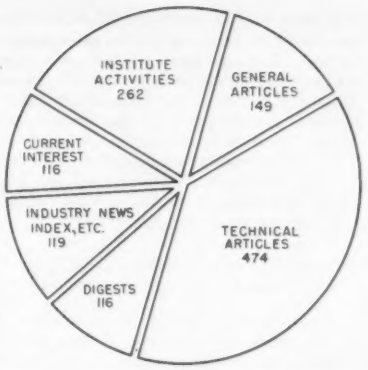


Fig. 1. Distribution of 1,236 editorial pages in 12 issues of *Electrical Engineering* for the year ending April 30, 1956.

Advertising. This activity has been increased through the addition of a space salesman to the staff, the opening of a West Coast advertising office, and increased promotion. The downward rate in the loss of advertising pages has been checked and turned upward beginning with the February issue. The increase in the number of pages in the first quarter of 1956 compared with the first quarter of the previous year was 12.1 per cent. This compares with an increase of 5.9 per cent for an industrial group of approximately 200 business publications and an increase of only 3.8 per cent for 14 leading electrical publications over the same period. The total number of advertising pages for the year ending April 30, 1956, was 951 as compared with 920 for the previous year. Gross billings were $75,850 in excess of the gross billings of the previous year. This was principally due to the 20 per cent increase in rates effective January 1, 1955. Plans are in prospect to open a Midwest advertising office with an additional salesman and to increase the research and promotional efforts.

Bimonthly Publications. These publications fill a specialized need and contain all of the formally approved meeting papers collated with the discussions at the end of each paper so that the technical material is available promptly within several months after the meetings. The editions of *Com-*

Table VI. Comparison of Subject Matter in *Electrical Engineering* with Primary Interest of Members

	Primary Interests of Members (1951 Questionnaire)		Technical Articles in *Electrical Engineering* (Per Cent)		
	Number	Per Cent	1953	1954	1956
Science and Electronics	3,268	16.9%	38.4%	26.9%	39.5%
Communication	2,562	13.2	10.3	19.3	14.7
Power	8,537	44.0	20.5	26.9	21.1
Industry	3,231	16.7	12.0	14.8	12.8
General Applications	1,405	7.2	18.8	12.1	11.9
None	393	2.0			
Total	19,396	100.0%	100.0%	100.0%	100.0%

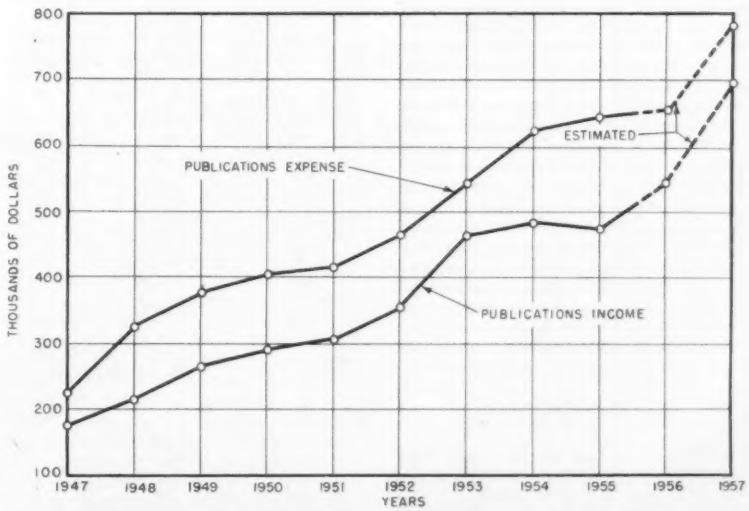


Fig. 2. Publications expenses and income from publications for the fiscal year. Year ending April 30.

munication and Electronics and *Power Apparatus and Systems* have each increased by 900 copies during the year and the edition of *Applications and Industry* has increased by 600 copies. Beginning with the March and April 1956 issues, the contents of each of the three bimonthlies has been cross referenced by publishing the contents of the other two bimonthlies on the inside front and back covers of each issue. The Committee has given careful consideration to ways ahd means of merchandising the publications to make the availability of these publications better known.

Special Publications. Nine special publications were issued during the year with a total of 1,080 pages of technical material. Five of these contained the papers and discussions from as many technical conferences, whereas four originated as special projects of the technical committees.

Transactions. Volume 74 of the 1955 Transactions will be issued in three parts: Part I. Communication and Electronics; Part II. Applications and Industry; and Part III. Power Apparatus and Systems. All three parts contain a total of 430 papers in 2,766 pages, which is a 9.9 per cent decrease from the number of pages issued in Volume 73 of the previous year. The Transactions serve a useful purpose to members and libraries by preserving a record of the advancement of the art in permanent archives.

Year Book. The Committee has recommended that the title of the Year Book should be changed to "Directory of the AIEE, 1956–58" and the policy of issuing this publication every two years should be continued. The Directory will be distributed to all officers and committees without charge and the publication will be sold to members at $2.00 per copy. It was further recommended that the first listing should be alphabetical (instead of geographical) with addresses and affiliations as at present. The secondary listing is to be by states and cities giving names only.

Conclusions. In general, the publishing position of the Institute has been greatly improved without any decrease in service to members. Fig. 2 shows the total expenses and total income from publications over the past 11 years. The net cost of publications has been reduced from a high of $171,000 in 1955 to $97,000 in the year ending April 30, 1956, and for the coming year it has been estimated that the net cost will be $87,500. These gains are attributable to increased income from advertising, the use of a less expensive paper, and the slight decrease in the number of pages published in the bimonthly publications and Transactions. Other publishing costs have increased and with the growth in membership and a larger student enrollment the circulation of *Electrical Engineering* has increased from 61,000 copies to 64,900 copies during the year.

COMMITTEE ON RESEARCH

The Committee on Research has given careful and continued study during this past year to its purposes and objectives. The Committee feels a major responsibility to direct the attention of all Institute membership to new areas where research effort may be promising or badly needed to advance the interests of the profession, or to areas where research effort may appear to be inadequate to meet needs of the profession or a segment of industry served by the profession. Effort has been concentrated on the latter area, calling attention to the needs for research in the electric utility and power systems industry. The Committee approved the following statement of objectives with respect to the electric power industry:

Objectives of AIEE Committee on Research with Respect to the Electric Power Industry

The dynamic prosperity of America rests on a foundation of expanding energy availability. Further improvement in our standard of living can be achieved only through continuing to make available to all more and more energy in an easily controlled form. Electric energy is the most versatile and easily controlled form of energy available to us and is the keystone of our industrial economy. It performs a myriad of tasks easily, economically, and quickly to make life easier and more pleasant in the home, office, and factory. Each day new uses are found, new processes developed, and new machines constructed to utilize it more effectively.

The electric power industry has experienced an explosive growth during the past decade, exceeding in rate of growth that of Gross National Product, Federal Reserve Board Index, and other indexes. Present forecasts indicate that on a national basis it will double each decade for the foreseeable future and these forecasts must be reached or exceeded if we are to continue to expand the output of goods and services. It is and will continue to be the essential ingredient in our rising standard of living.

Present knowledge can handle the problems of today and possibly tomorrow, but when the use of electric energy doubles and doubles again and yet again, will present knowledge and methods suffice? In only 30 years we will require eight times the present capacity—nearly a billion kilowatts! Will the present methods of generation, transmission, and distribution be adequate to supply the energy requirements at that time?

The use of nuclear fuel for the generation of electricity will undoubtedly be an economic reality but this is only a small segment of the over-all problem. Energy must be delivered to the ultimate consumer and, in high load density areas, the problems of land availability and space and thermal capacity in the street are already severe. Is there new knowledge as yet undiscovered that may ease this burden?

The Committee on Research is directed by the Bylaws to stimulate research of interest to the Institute and to initiate and direct research investigations. It is the considered opinion of the Committee on Research that the interests of the Institute and the engineering profession, and the economic welfare of America are intimately concerned with a continuing expansion of energy availability and that long-range research programs should be encouraged among the electrical utilities, manufacturers, research foundations, and educational institutions. This research should endeavor to develop new materials, processes, or knowledge that will be needed over the longer term rather than be concerned primarily with present day operating problems. The implementation of such a program requires a statement of objectives for the guidance of the Committee and other groups whose co-operation is needed. These objectives are:

(1) To examine the research now being carried on by the electric energy industry, including electric power companies, manufacturers, and educational institutions, and to determine areas where such research appears inadequate or nonexistent.
(2) To state the growing importance of research throughout all types of industry and to evaluate its importance to the power industry.
(3) To study the long-term needs of the industry with respect to both the rapidly increasing needs for generation, transmission, and distribution of energy, and also to review the necessity for constantly improving the reliability of service to meet the public's complete dependence on such service.
(4) To outline the direction of an appropriate program of research and development in engineering, the physical sciences, and economics for the electric energy industry. Recommendations should be made regarding the initiation of desirable research in areas which are now inadequately covered. New areas of research should be pointed out, both those having a direct and tangible interest to the industry and those which may have only a contingent interest. This research should endeavor to develop new materials, processes, or knowledge that will be needed over the longer term rather than be concerned primarily with present day operating problems.
(5) To study and evaluate the relation between such a recommended research program and the opportunities afforded engineers and scientists for a rewarding career in the power industry. Recognition should be given to the potential benefits of such a program to educational institutions in the development of staffs who will have an interest in the problems of the electric power industry and the ability to apply creative thinking to their solution. A better understanding is needed of the waning interest of the staffs and students of educational institutions in the power industry.

At the Winter General Meeting the Committee on Research sponsored sessions to direct attention to research for the electric utility industry in foreign countries (Italy, Sweden, England, and Japan); to research activities and possibilities for new sources of energy; and to the current situation regarding the supply of young engineers entering the industry, particularly as that supply may be affected by research activity within and for the industry.

The Committee will continue to review research for the electrical utility industry in other countries (Germany, France, etc.); and is co-operating with Eta Kappa Nu, the Committee on Education, the Committee on Student Branches, and the Institute of Radio Engineers to make a full survey of plans and attitudes of graduating electrical engineers.

COMMITTEE ON SAFETY

The Committee on Safety continued its promotional efforts of electrical safety by

Table VII. Section, Subsection, and Technical Group Statistics

	For Fiscal Year Ending April 30*													
	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956
Organizational Units														
Sections	73	73	73	75	71	81	85	87	89	94	97	100	107	109
Subsections	3	6	13	27	35	41	49	51	54	54	51	57	64	62
Technical groups	17	31	54	86	119	111	114	103	100	102	123	115	125	118
Meetings														
Section	536	586	617	675	723	757	845	886	924	966	960	1,028	1,079	1,071
Subsection	10	37	89	150	190	251	329	359	376	331	344	407	421	385
Technical Group	52	115	176	359	460	455	440	438	427	443	463	488	540	619
Joint									3	22	26	27	16	24
Total meetings	598	738	882	1,184	1,373	1,463	1,614	1,683	1,730	1,762	1,793	1,950	2,056	2,099
Attendance														
Section meetings	60,932	55,307	64,621	77,521	115,171	77,386	85,955	88,799	87,380	85,125	92,464	92,522	91,341	83,604
Subsection meetings	617	1,853	5,074	8,418	12,111	14,437	18,807	20,252	16,680	13,735	13,825	16,703	15,692	13,546
Technical group meetings	4,544	25,079	26,683	30,706	27,891	30,782	27,471	32,919	22,028	27,195	27,093	24,539	25,764	27,692
Joint meetings									406	2,746	2,199	2,027	1,283	1,573
Total attendance	66,093	82,239	96,378	116,645	155,173	122,605	132,233	141,970	126,494	128,801	135,581	135,791	134,080	126,415

* *For statistics for 1939–42 see 1954–55 report*

sponsoring Safety Sessions and encouraging active consideration of safety in discussion and papers of other Institute groups.

At least one Safety Session was sponsored by the Committee at each of the General Meetings. Papers dealing with such general interest electrical safety subjects as electric shock, resuscitation, grounding, and the like were presented. Several of these papers were presented before the entire membership either as technical papers or through publication in *Electrical Engineering*.

Through the co-operation of the Technical Division Liaison Representatives several papers treating specific aspects of electrical safety peculiar to the scope of the Division were presented. Authors were further encouraged to include safety as an item meriting equal engineering consideration.

The promotion of safety in other groups of the Institute included the completion of a "Guide for Safety Activities for Geographical Sections and Subsections." In co-operation with the Sections Committee this Guide was made available to all Sections and Subsections and will hereafter be distributed periodically.

A similar guide for use of Student Branches is now in process of preparation. It is expected that such a guide will be completed within the current year.

The Bibliography of Electrical Safety was brought up to date and released as a special technical paper. The Bibliography treats the subject under the headings: (1) Electrical Accidents and Their Causes, (2) Accident Prevention Methods, (3) Effects of Electrical Shock, (4) Resuscitation, and (5) Safety Codes and Standards.

Efforts were initiated to encourage the consideration of safety in connection with papers to be presented at District Meetings and at Special Technical Conferences.

Liaison activity with groups outside the Institute on common electrical safety problems seems to be increasing and a separate subcommittee was set up to co-ordinate such activity.

Plans are being developed for collection of information on a national basis concerning causes of electrical shock accidents. Both the Edison Electric Institute and the U. S. Coroners Association have indicated a willingness to co-operate in such a survey.

The support which the Committee on Safety has received for their efforts in promoting electrical safety leads to the belief that the membership is recognizing the vital part that safety plays in the electrical industry.

SECTIONS COMMITTEE

The Sections Committee met at Swampscott, Mass., on June 27, 1955. As a result of committee recommendation and later approval by the Board of Directors, the Sections will now receive their full annual appropriations without reduction because of previous reports of unexpended balances. This is a realistic recognition of the Sections' fiscal operations. The Board also approved Committee recommendations that Institute membership mailing lists be used solely for Institute activities, and that lists of Institute publications of interest to Sections should be circulated to the Sections annually by the Secretary.

The annual Conference of Section Delegates at Swampscott on June 28, 1955, covered a broad scope of topics having general interest to the Sections. Section Growth Awards, earned by a combination of increased membership and meeting attendance, were won by the Los Angeles and Connecticut Sections of the "larger-than-average" group and by the Jacksonville and Providence Sections of the "smaller-than-average" group. Presentation of engraved gavels and certificates was by J. L. Fuller, Sections Committee Secretary.

With Sections Committee Chairman W. R. Hough acting as Conference Chairman, the group heard inspiring messages from President Monteith, President-Elect Hooven, and others, as well as Chairmen of national committees on Student Branches, Membership, Transfers, Public Relations, Education, Planning and Co-ordination, and Safety.

A portion of the afternoon session was devoted to Section activities and local Section problems in two discussion groups of delegates from "larger-than-average" and "smaller-than-average" Sections.

Shortly after the Swampscott meeting, the Sections Committee was invited by the Board of Directors to assist our management consultants in a program of experimental Section meetings using the theories and principles of "group dynamics" or "audience participation" to stimulate member interest and activity in Section meetings. Two such meetings, under the general supervision of the management consultants and the Sections Committee, were held in Washington, D. C., and Canton, Ohio. Results in both cases showed 95 per cent enthusiastic approval in evaluation ballots turned in by those attending the meetings. Much more will be heard of this activity in the future.

During the year, minor adjustments and corrections of errors in assignment of territory to the Sections have been effected. Discussions of further territorial adjustments have been carried on as a routine activity of the Sections Committee.

The Sections Committee met again in New York on January 30, 1956. A committee recommendation, subsequently approved by the Board of Directors and submitted to the membership of the Institute by a mail ballot, would amend the Constitution and Bylaws to require that the Section Delegate to the annual Conference at the Summer General Meeting shall be the incoming or incumbent Section Chairman rather than the outgoing Chairman.

Prof. J. J. Carey's subcommittee report on minimum membership and activity of Sections and Subsections was referred to the Secretary of the Institute for further study by the Board of Directors. It was recommended that Sections with less than 35 members should revert to Subsection status. To establish a Subsection, 15 or more members would be required with a minimum of 10 members to maintain Subsection status. Subsections would hold and report at least four meetings per year.

After two years of work, a Subcommittee under R. E. Kistler has compiled the final draft of a much-needed "Sections Operations Manual." The Board of Directors has approved printing of this manual as soon as final editing is completed. Another Subcommittee under W. A. Howe has revised the "Section Activities" booklet for reprinting.

The informal meeting of Section Representatives with the Sections Committee was held in New York on January 31, 1956. The morning session was devoted to a prac-

tical demonstration of "group dynamics" in action, supervised by our management consultants and with Sections Committee Chairman Dixon Lewis acting as moderator. Questions developed by this technique were capably answered by Officers of the Institute and Chairmen of various national committees who were present at the meeting.

The afternoon session was led by Public Relations Committee Chairman F. S. Black as a Public Relations Workshop. The importance of PR at the local, intermediate, and national levels was presented in an interesting and competent manner.

Development of new Sections and Subsections has been relatively static since the Annual Meeting (Table VII). One new Section, the 109th, which embraces the State of Maine and is called the Maine Section has been established. The Mexico Section has formed a new Subsection in Monterrey, Mexico, making a total of 62 Subsections.

To summarize this annual report, the Sections Committee believes that as the result of recommendations of our management consultants, two of the most important developments facing the Sections are:

(1) Widespread information, acceptance and application of the principles of "group dynamics" to the conduct of Section, Subsection, and Technical Group meetings.
(2) Recognition and development of Technical Groups as the most important unit of Section organization and activity, and development of new channels of communication and integration of Technical Groups with the national technical and administrative organization of the Institute.

STANDARDS COMMITTEE

The Standards Committee has continued its activity to strengthen the bonds between the Technical Committees of AIEE and the members who are acting as AIEE representatives to various standardizing bodies. It has completed the procedure for a close liaison between the Technical Committees and these members. The Procedure Subcommittee of the Standards Committee has been assigned the following tasks:

(1) Develop a procedure for periodic review and reaffirmation of standards for which AIEE is responsible.
(2) Study the over-all handling of AIEE Standards and recommend procedure by which all standards could be handled as quickly as possible, consistent with the aims of the AIEE.
(3) Develop a procedure for handling as quickly as possible standards which come to AIEE for approval, which are to be submitted to ASA on the Existing Standards Basis.
(4) Recommend a method for handling standards of an unusual nature, or standards which, because of special conditions, require unusual procedure.
(5) Consider the matter of standard definitions, and the appropriate relationship of AIEE to ASA *C42*, "American Standard Definitions of Electrical Terms."

The Procedure Subcommittee met and has made tentative proposals. It is believed that the completion of this assignment will strengthen the AIEE's position in electrical standardization work.

The following standards projects have been approved:

Addendum to AIEE No. 1—General Principles Upon Which Temperature Limits Are Based in the Rating of Electric Machines and Other Equipment
1C—Test Code for Evaluation of Systems of Insulating Materials for Random-Wound Electric Machinery
28B—Revised Report on Valve and Expulsion Type Lightning Arresters
51—Guiding Principles for Dielectric Tests
54—Standard, Test Code, and Recommended Practice for Induction and Dielectric Heating Equipment
57—Proposed Test Procedure for Evaluation of the Thermal Stability of Enameled Wire
58—Proposed Standard for Induction Motor Letter Symbols
59—Proposed Test Code for Metallic Rectifiers
506—Proposed Test Code for Power Factor Testing of Distribution Transformers

The following was approved for publication as a Committee Report:

955—Guide for Evaluating the Effect of Solar Radiation on Outdoor Metal-Clad Switchgear

The following were approved for American Standards under ASA procedures:

C37.2—Automatic Station Control, Supervisory, and Associated Telemetering Equipment (just recently submitted to ASA for their consideration)
C48.1 (AIEE No. 16)—Electric Control Apparatus for Land Transportation Vehicles

Underwriters' Laboratories' Standards submitted on Existing Standards basis:

Transformer Type Arc-Welding Equipment
Cord Sets and Power Supply Cords
Specialty Transformers
Wire Connectors and Soldering Lugs
X-Ray Equipment

COMMITTEE ON STUDENT BRANCHES

The Committee on Student Branches is gratified to report that Student membership is again on the increase. Student membership as of May 1, 1956, was 9,458, a 23.4 per cent increase over the membership of 7,666 as of May 1, 1955.

During the year, the Board of Directors approved the formation of one Student Branch and six Affiliate Branches.

Two meetings of the Committee were held: Swampscott, Mass., on June 29, 1955, and New York, N. Y., on February 1, 1956. These were supplemented by numerous subcommittee meetings throughout the year.

This past year, the Chairman of the Committee on Student Branches visited 7 of the 11 Districts either at the meeting of the District Committee on Student Activities or at the Prize Paper Competition. These visits have proved most helpful in observing the operation of such meetings and participating directly with the "line" organization of our student activities. These visits were also helpful to the Districts by having present a national representative to present information on national events in Student Branch activities and to assist in answering various questions raised.

The AIEE-IRE Co-ordinating Committee, of which the AIEE representatives are W. B. Morton and Dr. J. D. Tebo held three meetings during the year. At these meetings, activities, projects, and programs of each society were presented so that each group is acquainted with what the other one is doing. Items of mutual interest to both societies are thoroughly reviewed.

The Committee, through the Student Branches, assisted in the promotion of the Eta Kappa Nu "Survey of Employment Opportunities for Electrical Engineering Graduates." Financial support by the AIEE was approved, if necessary, to assist in underwriting some of the costs of this survey.

The Committee was organized this year into 11 working Subcommittees, each assigned a major activity of Student Branch work.

Finances. A complete analysis of costs of Student Branch operation was made. All items chargeable to operation of Student Branches were considered, including travel, prize paper competitions, etc. In the past, many of these costs have been included in budgets of other committees, so that no true estimate was available on the cost of Student Branch operations. It was found that the current average expenditure is approximately $85,000. Deducting the amount paid by Student members for dues, the actual cost to the Institute is approximately $55,000 or about $7 per Student member.

Publications. A survey among the Branches reported almost unanimously that material of student interest should be published in *Electrical Engineering* rather than in a separate publication devoted to Students. As a result, the February issue of *Electrical Engineering* had a student section "In Educational Circles" of 28 full pages which included articles of interest to students by top electrical engineers, papers by several students, news items and reports of Branch activities. There were 10,000 reprints made and some sent to each Branch for distribution to nonmembers. Each issue since then has had at least several pages devoted to such items. Another "Student Issue" is under way for the October 1956 issue.

Constitution and Bylaws. In order to remove contradictory statements and to clarify the sections of the Constitution and Bylaws pertinent to Student Branches, a complete review of all such sections has been made. These have resulted in numerous changes which have been approved by the Committee and which were submitted to the Constitution and Bylaws Committee for implementation.

Branch Prize Paper Competitions. A thorough analysis of Prize Paper Competitions indicates that 10 of the 11 Districts hold

Table VIII. Branch Statistics

	For Fiscal Year Ending April 30						
	1950	1951	1952	1953	1954	1955	1956
Number of Branches	130	133	132	133	135	135	149
Number of meetings held	1,318	1,303	1,178	1,250	1,116	1,158	1,357
Total attendance	81,815	63,369	49,324	45,895	49,213	53,325	79,291

District competitions with only approximately 65 per cent of the Branches represented. Various steps have been taken for increasing interest in presentation of papers to aid the Student in learning to speak and write more effectively. In four of the Districts this year, trips were awarded to 1st, 2nd, and 3rd place winners and their counselors to encourage participation in the competitions.

Sections Co-ordination. A complete review was made of ways in which Sections can aid the Branches. A number of Sections have adopted various policies suggested, particularly the appointment of a Committee on Student Activities. A number of others are considering supplementing their present programs.

Student Branch Manual. The Manual was completely revised, based on suggestions by both Counselors and Students. It will be issued this Fall in loose-leaf form.

Promotional Folders. A new edition of a folder to stimulate Student membership and interest in AIEE was prepared. Sufficient copies were sent to each Branch for distribution to all electrical engineering students. Bulletin board posters were prepared every other month to direct attention of Students to articles in *Electrical Engineering*. Frequent letters were sent to the Branches, advising them of new policies and practices, as well as reminders of routine business.

Meeting Reports. At the beginning of the year, a revised Meeting Report Form was prepared to simplify reporting procedures and to aid in securing better statistical data. A further analysis is currently under way regarding the use made of Meeting Reports, types of material included, statistical data required, and items of a similar nature.

Student Branch Packet. Copies of the manual, report forms, promotional folders and membership applications were prepared in a packet which was sent to each school, early in the Fall. This procedure was well received, since it greatly reduced time required of Counselors and Students in requesting such material.

Sound Slide Film Program. This program, now in its second full year of operation, continues to be well received. During the year, two additional programs were released, with several others currently under way. Each District schedules the showing of these programs within its own District. After making the rounds of the Branches, all programs are maintained on file for use by any Branch at any time. This will result in the establishment of a rather complete Sound Slide Film library within several years.

Branch Application. A procedure was developed to devise a standard method for requesting and approving the organization of a Student Branch. The Branch application requests certain data be furnished by the school wishing to organize a Student Branch. This request is reviewed by the Chairman of the District Committee on Student Activities, the District Vice-President, and the Chairman of the Committee on Student Branches. If approved by each of the above, it is submitted to the Board of Directors for final action.

Graduate Students. During the year, approval was granted that graduate students who are eligible for the grade of Associate Member may be admitted without payment of initiation fee and may receive all Associate Member privileges at the reduced cost of $5 per year. Such graduate students are considered members of the Section in the territory in which they reside.

The Committee on Student Branches has requested that all AIEE members support the Student activities. Criticisms and suggestions are solicited from all members. It is imperative that we maintain a solid professional base in our Student Branches, since the Student members of today are the Institute leaders of tomorrow.

COMMITTEE ON TECHNICAL OPERATIONS

Meetings of the Committee on Technical Operations (CTO) have been held in connection with each of the three General Meetings of the Institute: Swampscott, June 26, 1955; Chicago, October 5, 1955; and New York, February 1, 1956. In carrying out its objectives, the Committee has been concerned with the following subjects:

New Technical Committees. Three new technical committees have been established during the past year; Committee on Communication Theory (Communication Division), Committee on Dielectrics, and Committee on Solid-State Devices (Science and Electronics Division). Scopes of these committees have been prepared and have been approved by CTO, and the committees have been functioning for much of the past year.

Joint Division Committees. A subcommittee established to consider the type of organization needed for treatment of topics of concern to several Divisions, proposed the formation of Joint Division Committees, to be established by CTO for each specific purpose. Such committees are intended as ad hoc committees, or to remain in existence only as required until their assignments are completed. They should be used sparingly, and only when other more informal co-operative efforts between Divisions prove ineffective. The Joint Division Committee should act to guide and coordinate activities in the assigned area, whereas interested Technical Committees should do the work of organizing technical sessions and procuring papers. Approval of the subcommittee's report was voted at the October 5, 1955, meeting of CTO.

Joint Division Committee on Automation and Integrated Data Processing. The first Joint Division Committee, with the aforementioned title, has been appointed. It includes, among others, representatives of the six Divisions, since it is believed that all Divisions of the Institute have an interest in this subject. Efforts are being made to begin operation immediately.

Instrumentation Division. Because of its broad scope of activities, the Committee on Instruments and Measurements has been functioning for some time in a similar way to that of a technical division. On petition by this committee, the Committee on Technical Operations recommended the formation of an Instrumentation Division. The petition was approved by CTO, and presented to the Board of Directors, where approval of the new Division was voted at the April 3, 1956, meeting of the Board. It is expected that the new Division will begin its operations at the start of the AIEE fiscal year, August 1, 1956.

Forum of Technical Committee Chairmen. Three forums of technical committee chairmen have been held during the past year—at the Summer, Fall, and Winter General Meetings. These meetings are particularly valuable both to the incoming technical committee chairmen, and to those who have served in that capacity, for the exchange of ideas and of Institute policies. Some of the discussions have concerned the facilities and conduct of technical sessions, registration fees for meetings, scheduling and forecasting of sessions and papers, prices of preprinted papers, and opinion surveys carried on by the Institute.

Nuclear Engineering and Science Congress. The AIEE participated in a Nuclear Engineering and Science Congress, December 12–16, 1955, in Cleveland, sponsored by the Engineers Joint Council (EJC). Twenty-six societies co-operated, of which 17 presented papers. While under the general jurisdiction of CTO, the Nucleonics Committee of the Science and Electronics Division was the specific technical committee involved.

It is now proposed to hold a second EJC Nuclear Congress March 10–16, 1957, in Philadelphia. As in the case of the Cleveland Congress, there will be an exhibit accompanying the meeting. The general sponsorship will be under EJC, but under the operating management of a group of representatives of AIEE, American Society of Civil Engineers, American Institute of Mining & Metallurgical Engineers, American Society of Mechanical Engineers, and American Institute of Chemical Engineers.

Improving Division Service to the Institute Membership. Studies by a special subcommittee on improving service of the Institute to its members have been carried on during the past year. While these studies have not yet reached a point where concrete recommendations are possible, some direction as to where improvements might be made has been gained from the Opinion Survey (Membership Appraisal) conducted under an assignment of the Committee on Planning and Co-ordination. A second survey, devoted primarily to the technical activities of the Institute, is now proposed, which should provide information particularly appropriate to the studies of this subcommittee. The Committee on Technical Operations has recommended to the Board of Directors that this survey be made.

COMMITTEE ON TRANSFERS

The members of the Committee on Transfers, through personal correspondence, have contacted each Section of the Institute urging them to have active committees on transfers.

Nearly all of the Sections have such a committee and from the partial reports received it is evident that these committees are effective in stimulating members of the AIEE in obtaining as high a grade of membership as that for which they are qualified. Table I shows the number of transfers during the past year.

The committee had one meeting during the Winter General Meeting of the Institute and spent several hours in reviewing material for a revision of the booklet "A Guide to Transfers of Membership." The ideas of the different members of the Committee together with the changes in the Constitution, Bylaws, and Code of Practice of the Board of Examiners were melded together. The Secretary of the Committee has edited and arranged copy so that this revised guide can be issued late in the Summer of 1956.

TECHNICAL DIVISIONS AND COMMITTEES

Communication Division

COMMITTEE ON COMMUNICATION SWITCHING SYSTEMS

In its technical sessions, the Committee is covering a variety of subjects which are of interest not only in the field of telephone switching, but also in the broader field of information processing. These include new developments in switching apparatus, telephone switching systems for both local and long distance service, message accounting systems, and new circuit techniques and design principles. Several papers on electronic switching circuits and the design of logic circuits have been of particular interest. Technical sessions during the Summer, Fall, and Winter General Meetings were well attended. Two technical sessions are planned for the 1956 Summer General Meeting with papers covering subjects ranging from apparatus to systems. Plans are being made for the 1956 Fall General Meeting, and it is expected that several papers on remote line concentrators will be available for presentation at that time. Preliminary plans are being made for the 1957 Winter and Summer General Meetings.

COMMITTEE ON RADIO COMMUNICATIONS SYSTEMS

Much attention was directed by the Committee during the year to means of further increasing the effectiveness of its activities. One proposal considered was the desirability of forming a number of subcommittees—not only for the purpose of encouraging development of special papers, but also to decrease the load of details funneling through the chairman. It was concluded that the function of the various subcommittees might make the committee structure too inflexible and that it would be preferable to concentrate instead on specific but different themes for the various technical sessions. In this manner, the distribution of committee membership both geographically and industrially could be brought to full bearing on development of papers for each theme. In addition, the appointment of a temporary subchairman for a particular technical session would distribute the workload satisfactorily.

Whereas these organizational concepts have not yet been fully tested, the evidence obtained thus far indicates that continuation of the present full committee organization without subcommittees and concentration on special themes represents a desirable goal inasmuch as it tends to increase the enthusiasm of committee members, prospective authors and, of considerable significance, tends to increase the attendance at technical sessions.

Although emphasis by the committee continues to be placed on the systems aspects of communications, the inclusion of a few papers on individual equipment items and components has been found to be desirable. The past year saw the inclusion of several papers describing entire communications systems with some emphasis on operations and maintenance.

There has been continued rapid expansion of the use of microwave radio for public as well as private communication systems. There has been extensive work in the use of tropospheric and ionospheric scatter for long-wave radio propagation transmissions.

The committee sponsored one technical session at the Summer General Meeting, one at the Fall General Meeting, and two at the Winter General Meeting. Two technical sessions are scheduled for the 1956 Summer General Meeting, and there is growing evidence of an increase of suitable papers.

COMMITTEE ON TELEGRAPH SYSTEMS

The sessions of the Committee on Telegraph Systems and technical papers submitted, during the past year, have reflected increased interest and activity in facsimile, teletype applications in integrated data processing, higher speeds of teletype transmission, and application of transistors and other new-art techniques.

The committee sponsored a technical session at the Fall General Meeting and two sessions at the Winter General Meeting. Full committee sessions were held at both of these meetings. Plans have been completed for a technical session at the forthcoming Summer General Meeting.

Printing Telegraph Subcommittee held two meetings and completed preliminary work with respect to tolerances believed to be applicable to printing telegraph apparatus. At the present time, work is proceeding on a study relative to the methods of tests and the test circuits and apparatus which should be used in determining operating margins.

COMMITTEE ON TELEVISION AND AURAL BROADCASTING SYSTEMS

Technical sessions were sponsored by the committee at the Summer, Pacific, Fall, and Winter General Meetings. One of the sessions at the Winter General Meeting was sponsored jointly with the Committee on the Production and Application of Light. Two independent sessions were sponsored at all General Meetings. AIEE members and guests to the technical sessions heard papers and discussions on such timely broadcast subjects as: New Developments in Color Television, Closed Circuit Television, Satellite Television Broadcasting, Microwave Transmission, Television Measuring Equipment and Measuring Techniques, VHF-UHF Propagation, High Fidelity Audio Systems, and AM Transmitters. Those in attendance at the Winter General Meeting joint session were enlightened on the subjects of: Light Amplifiers, Studio TV Lighting, and Fluorescent Light Interference Voltages.

Committee meetings were held in conjunction with each General Meeting. There has been a great deal of discussion at these meetings concerning the need for more advance publicity for the technical sessions and for ways and means to increase session attendance. Such discussions brought out the fact that normally we try to fulfill two functions: (1) to provide papers of general interest to the membership of AIEE, and (2) to furnish more detailed papers of interest to engineers specializing in the broadcast field. Is this the correct approach? A questionnaire study has been made in an effort to try to get some indication as to how the committee should program its technical sessions.

Questionnaires were printed and distributed at all sessions of the 1956 Winter General Meeting which were sponsored by the CTABS. Neglecting the joint session returns, which are not considered representative for our committee, 53 replies were turned in at the end of two sessions. The combined results, in brief, of these two independent sessions give the following sample information: 34 of the 53 in attendance were members of AIEE; 12 had official duties in connection with AIEE such as speaker, committee member, etc.; 14 indicated a preference for specialized papers whereas 27 preferred papers of a general nature; only 18 of the 53 said that their main interest was directly, or indirectly, related to the field of television and aural broadcasting; 28 of the 53 replying said that their expenses to the meeting had been paid by their employer; and 29 came to the Winter General Meeting specifically to attend technical sessions.

One of the activities of the CTABS has been that of recommending qualified engineers for advancement to Fellow grade in the AIEE. Six recommendations have been granted and none have been turned down.

COMMITTEE ON WIRE COMMUNICATIONS SYSTEMS

The Committee sponsored one technical session each at the Summer and Fall General Meetings and three at the Winter General Meeting. Again this year, the Winter General Meeting featured papers on the problem of providing low cost telephone service to rural subscribers by carrier. In this case, the discussion centered around the Western Electric P1 Carrier System, which is among first of the carrier systems to be completely transistorized.

Short haul carrier systems continue to be among the more important items under discussion. At least one paper at each general meeting during the past fiscal year has dealt with some phase of its development.

Another subject presented and which provoked lively discussion concerned coordinated protection in open wire joint use. A complete session at the Winter General Meeting sponsored jointly with the Committee on Transmission and Distribution was was devoted to this subject.

Other papers presented during the year dealt with problems encountered in providing communications in Canada, local telephone lines used for television pickup and progress in telephone transmission.

In view of the fact that operation and maintenance of electronic equipment used in wire and radio communications is becoming of increasing concern to the communications industry, the Committee is actively engaged in planning a number of sessions devoted solely to this subject. The other committees of the Communications Division are

being asked to participate in these discussions. The first sessions are being scheduled in conjunction with the 1956 Fall General Meeting and if sufficient interest is shown, further meetings or Special Technical Conferences will be held.

General Applications Division

COMMITTEE ON AIR TRANSPORTATION

The activities of the Committee on Air Transportation (ATC) have been diversified during the past year. Intentionally, more authors have been sought from those activities supplying components, utilizations equipment, and electronic devices for aircraft and missile applications. This program has met with success as is borne out by the Technical Conference on Aircraft Electrical Applications held in Los Angeles on October 25–27, 1955, and the Seventh District Meeting held in Dallas on April 2–4, 1956. The theme of the latter meeting was "Electricity in Aircraft" and was selected by the ATC for its 1956 annual session. There were 23 technical papers presented in 6 sessions for the first meeting and there were 35 technical papers presented in 8 sessions sponsored by the ATC for the second meeting.

Participation in these meetings by various facets of the electric equipment industry, the aircraft industry, the airlines, and the military services has been very good. Through the response to the programs sponsored by the Committee, it is believed the desires of the members are being satisfied.

The Committee has continued its efforts to co-ordinate its activities with other groups working in mutual areas of interest. Specific liaison appointments have been made to the Aircraft Industries Association and the A-2 Committee of the Society of Automotive Engineers.

At the present time, the five subcommittees of the ATC have active assignments on which they are working. Several design guides, test codes, standards, and revisions thereof should be completed in the next year.

The committee charged each of the subcommittees to review their organization to insure proper consideration of electric power for use on missiles. Some of the subcommittees are organized so that this specific area of interest does not require serious changes in organization. However, others are finding it desirable to establish Working Groups charged specifically with the responsibility for this particular problem.

In order to facilitate the organization of meetings, a tentative schedule of meetings has been agreed upon by the committee. These are as follows:

1957—May 7–9, Dayton, Ohio, Middle Eastern District 2 Meeting
1958—June 23–27, Buffalo, N. Y., Summer General Meeting
1959—June 22–26, Seattle, Wash., Summer General Meeting
1960—August—San Diego, Calif., Pacific General Meeting.

It is intended to keep this tentative schedule planned ahead four to five years so that the arrangements for a particular meeting can be made in a more leisurely manner.

COMMITTEE ON DOMESTIC AND COMMERCIAL APPLICATIONS

This committee held its annual meeting during the 1956 Winter General Meeting in New York, N. Y. The scope of the committee has been slightly enlarged to include "farm buildings" in the domestic, commercial, or institutional premises with which we are concerned. The principal work of the committee continues to be carried on by the subcommittees.

Liaison is maintained with the AIEE Standards Committee, two ASA Sectional Committees, the Inter-Industry Farm Electric Utilization Council, and the AIEE Subcommittee on Single-Phase and Fractional Horsepower Motors.

Subcommittee on Electric Space Heating and Heat Pumps (East). This group again sponsored a technical session at the Winter General Meeting. This was in the form of a technical conference or round-table type of meeting. This departure from the usual type of session was found to be highly successful. Interest in the heat pump and air-conditioning field continues at a high level.

Subcommittee on Electric Space Heating and Heat Pumps (West). This group is planning to sponsor at least one technical session at the Summer and Pacific General Meeting at San Francisco, Calif., this June. Five interesting papers will be presented. This subcommittee has shown a great deal of interest in the electric space heating aspect of their assignment and, in spite of the distances involved, has been very active this past year.

Subcommittee on Domestic Appliances. This group has held its Seventh Appliance Technical Conference in Milwaukee on May 14 and 15. The major theme of the conference will be "Motor Driven Appliances." Interest in built-in domestic appliances has continued and more appliance manufacturers have entered the field. There has been a growing interest in the use of color. The possible future use of higher secondary voltages for utilization devices is attracting the attention of engineers in both the manufacturing and utility fields. This subcommittee intends to keep abreast of such developments insofar as they affect the design or application of domestic appliances.

Subcommittee on Farm Electrification. This group is planning a Special Technical Conference in Memphis, Tenn., this Fall. This will be a 3-day session and will be the second Conference of this type, the first having been held in Chicago, Ill., in March 1955. Based on the preliminary interest, a highly successful meeting is expected.

COMMITTEE ON LAND TRANSPORTATION

The Standard No. 11 Subcommittee will send the final draft of the new rules to the Standards Committee soon.

The Standard No. 16 Subcommittee already has finished its assignment and the rules have been printed and distributed. Three new subcommittees are being organized: (1) Standardization of Wiring Diagrams for Land Transportation, (2) High-Speed Train Resistance, and (3) Diesel-Electric Locomotive Motor and Generator Insulation.

The Subcommittee on Wiring Diagrams will work with the Association of American Railroads Mechanical Division, Electrical Section Subcommittee on Wiring Diagrams for the purpose of eventually handling this matter with the ASA. A paper or progress report is now being prepared for the Fall General Meeting.

The High-Speed Train Resistance Subcommittee is going to evaluate presently known high-speed train resistance data of domestic and foreign origin for the purpose of general usage in the higher speed operation we are encountering in passenger and freight service. This may turn out to be quite an assignment.

The Diesel-Electric Locomotive Motor and Generator Insulation Resistance Subcommittee may also be facing quite an assignment. Two papers were presented by the Committee on Land Transportation on this subject at the Winter General Meeting, namely *CP56-286* and *372*. C. E. Asbury, Chairman of the AIEE Insulation Subcommittee is entertaining a suggestion for a proposed consolidated reprint of these two papers together with *56-45*, *51*, and *176*. The Subcommittee will be formed in the near future. There is a great and practical need for information which will make it possible to set up routine maintenance testing procedures for checking insulation resistance.

An effort is being made to expand railroad membership and participation in the committee. Also, the committee is now collaborating with the aforementioned committee of the Association of American Railroads.

There may be a need for collaboration with the ASME Railroad Division Committee on the formerly mentioned High-Speed Train Resistance assignment.

The committee is conscious of the growing traffic congestion in large urban areas and is actively interested in rapid transit which is the theme of the technical paper sessions at San Francisco.

A paper has been presented on lightweight high-speed passenger train equipment and more are scheduled for the future.

The automatic hump and switching yard was the subject of a paper recently and will be of another at San Francisco.

COMMITTEE ON MARINE TRANSPORTATION

The Committee held meetings on May 27th and October 7, 1955, and on May 11, 1956. Consideration was given at these meetings to desirable revisions and additions to AIEE Standard No. 45, "Recommended Practice for Electric Installations on Shipboard."

Five members of this committee represented the United States at a conference of Technical Committee No. 18 of the International Electrotechnical Commission at The Hague in Holland, December 6–10, 1955. Agreements previously reached at the 1954 conference in Philadelphia, Pa., were extended to include certain subjects not previously agreed upon. The resulting code of "International Recommendations Concerning Shipboard Electrical Practices," the first edition of which will be issued this year, is expected to form the basis for marine electrical standardization work throughout the world.

The committee sponsored a marine session

at the 1956 Winter General Meeting in New York, N. Y. The session was well attended and the papers promoted some spirited discussions.

COMMITTEE ON PRODUCTION AND APPLICATION OF LIGHT

A Winter General Meeting session was jointly sponsored with the Committee on Television and Aural Broadcasting Systems. The session comprised subjects relating to the scopes of both committees and served to strengthen our opinion that closer liaison with other committees is the best method of fulfilling our obligation to Institute members, that is, informing them of progress in the field of illumination. Our paper on the "Mechanisms of Electroluminescence and of Radiation Amplification" and the other on the "Evaluation of Radio Influence Voltages in Fluorescent Lighting Systems" were compatible with those sponsored by our cooperating committee on "Converting Studio Lighting from Black and White to Color" and a paper on the "Use of Heat Control Coatings To Reduce TV Studio Temperatures."

The Committee met during the Winter General Meeting and discussed the possibilities of closer liaison with other technical committees, more lighting articles in *Electrical Engineering*, and more concentration on the Summer and Pacific, and the Fall General Meetings. Subcommittees for the Midwest area and the Pacific Coast are being finalized and will be in operation next year to provide a better means of formulating programs at the Pacific General and Fall General Meetings.

Industry Division

COMMITTEE ON CHEMICAL INDUSTRY

Again this Committee has been very active over the past year. The equivalent of six half-day sessions were presented at the three General Meetings. A session was also sponsored by this Committee at the Pacific General Meeting last year. These sessions were well diversified including a symposium, a panel discussion, and papers. The Committee also has two groups working on Standards with other AIEE committees.

The Batteries Subcommittee sponsored a session at the 1955 Fall General Meeting and expects to sponsor more frequent future sessions. The subcommittee is also considering work on American and AIEE Standards.

The Cathodic Protection Subcommittee sponsored a session at the 1955 Pacific General Meeting and two papers at the 1956 Winter General Meeting. This subcommittee has been a regular sponsor of sessions at one or more of the Institute's General Meetings for a number of years. They have regularly contributed worthwhile papers on this subject.

The Chemical Processes Subcommittee sponsored one half of a session at the 1955 Pacific General Meeting and a full half-day session at the 1956 Winter General Meeting. The activities of this subcommittee have increased considerably over the past several years.

The Electrochemical Processes Subcommittee sponsored its Annual Session at the 1956 Winter General Meeting. The program was a symposium on "Preventative Maintenance of Large Rectifier Installations in Electrolytic Plants." This subcommittee is also working with the Switchgear Committee by providing a Working Group to investigate the fault current contribution from various types of electrolytic cells. This information will be valuable to the Switchgear Committee in working up application data for circuit breakers.

The Electrothermal Processes Subcommittee sponsored a session at the 1956 Winter General Meeting. This subcommittee has also provided a Working Group which is co-operating with the Transformer Committee in developing standards for furnace transformers. They are also considering an investigation of rectification occurring in furnace arcs.

The Pacific Coast Subcommittee is now fully organized and is well along in their plans for sponsoring two sessions at the forthcoming Summer and Pacific General Meeting with eight papers on interrelated subjects. It is expected that this group will be very effective in planning sessions for future Pacific General and other West Coast meetings.

The Committee as a whole sponsored a session at the 1955 Summer General Meeting which included a total of six papers.

At the South West District Meeting in Dallas, Tex., in April, two technical sessions were sponsored by committee members from that District, with interesting discussion ot the papers presented from the floor. The program committee of the South West District graciously consented to allow some of these papers to be re-presented at the Summer and Pacific General Meeting in San Francisco, Calif., under sponsorship of the Pacific Coast Subcommittee.

The main committee and all of the subcommittees have expanded and are now organized with a well-balanced membership consisting of electrical engineers from the industries covered, consulting engineers, and engineers from electrical manufacturers. The representatives from the chemical industry account for more than half of the committee. This balance of membership insures that the problem covered by the technical sessions will be of concern to the chemical industry.

COMMITTEE ON ELECTRIC HEATING

During the past year, the Committee on Electric Heating, through the Subcommittee on Induction and Dielectric Heating, has been collecting data and assembling reports which are to be filed with the Federal Communications Commission for assistance in writing new rules for radio interference from induction and dielectric heating equipment.

Plans have started and Toledo, Ohio, has been selected for the next two-day Electric Heating Conference which is to be held in April 1957. Some 16 papers will be presented.

Work is proceeding on the collection of technical data on electric heating for eventual publication by the Institute.

COMMITTEE ON ELECTRIC WELDING

Most of the accomplishments of this Committee during the fiscal year have been due to the work of the Subcommittee on Resistance Welding Instrumentation and the Subcommittee on Fundamental Arc Research.

The Subcommittee on Resistance Welding Instrumentation has nearly completed an exhaustive survey of the quantitative and qualitative requirements of instruments necessary for the determination of all welding machine, process, and power supply requirements. This survey will be published in report form during 1956 and will be submitted to the Committee on Instruments and Measurements for further action.

The Subcommittee on Fundamental Arc Research is in the process of preparing a brochure which will emphasize existing problems in an effort to stimulate further research by industry and Government agencies.

The major activity of the main Committee has been negotiation with the American Welding Society for the purpose of joint sponsorship of the Welding Conference to be held in Philadelphia, Pa., during the Spring of 1957. These negotiations resulted in a definite decision to participate and the Conference organization is well under way. Present indications are that at least five technical sessions will be sponsored by the Electric Welding Committee. This activity is the most ambitious to be undertaken by this committee to date.

COMMITTEE ON FEEDBACK CONTROL SYSTEMS

The Committee on Feedback Control Systems has sponsored two technical sessions at the Fall General Meeting and at the Winter General Meeting during the past season, and is sponsoring two technical sessions at the Summer and Pacific General Meeting in June.

The Committee also cosponsored a Conference on Nonlinear Control Systems with the ASME at Princeton in March. We feel this Conference was very valuable in fostering co-operation between feedback control groups in ASME and AIEE and will help working relations in the fields of terminology and definition.

The Committee is represented on ASA *C85* committee on terminology and definition for automatic control systems and is very active in contributing to this work.

In addition, the Committee has completed proposed terms and definitions for feedback control systems for consideration by AIEE and as a foundation of work for ASA *C85*. This proposal was ready for publication in May of this year.

The Committee has established during the year a Subcommittee on Definitions, Terminology, and Specifications for Components for Feedback Control Systems.

The Committee is also continuing work on a much needed extension of the Bibliography of Feedback Control Systems.

At present, the Committee is considering the scope and aims of the Committee in light of the present state of the art and will be prepared to make recommendations after the Committee meeting in the Fall.

In connection with the foregoing, we are considering the possibility of dividing the Committee into subcommittees according to technical specialities in the general field, this should increase the value of work done by the Committee in stimulating dissemination of information concerning progress in the feedback control systems field.

COMMITTEE ON GENERAL INDUSTRY APPLICATIONS

This Committee during the past year mainly has been concerned with the efficient

operation of its subcommittees. Most of the subcommittees serve their particular industries by presenting Conferences at regular intervals. These Conferences are now so well established that they are institutions in their particular fields. On the other hand, it is found that some of the subcommittees may serve better by adding their efforts to the conferences held by other subcommittees rather than staging their own.

The activities of the various subcommittees are as follows:

The Paper and Pulp Subcommittee is definitely operating successfully by staging conferences which complement rather than compete with The Technical Association of the Paper and Pulp Industry. The first one was held at St. Petersburg, Fla. with an attendance of 65. It also sponsored one at the University of Florida at Gainesville on March 8–9, 1956. Its plans for the future are to hold, alternately, Conferences at Georgia Institute of Technology and the University of Florida. Also, it plans to participate in the North Eastern District Meeting at Pittsfield, Mass., on May 1–2, 1957.

The Machine Tool Subcommittee did not hold its annual Conference in 1955 because of the National Machine Tool Builders' Association Show. It has scheduled a three-day Conference at Cincinnati, Ohio, in October 1956. The last one in Detroit, Mich., in 1954 had an attendance of 700. The Cincinnati meeting is expected to have an attendance of 1,000. This certainly is testimonial enough of the success of this subcommittee's work.

The Textile Subcommittee held a Conference in Raleigh, N. C., in 1955 with an attendance of 250. Another was scheduled for March 1–2, 1956, at Georgia Tech in Atlanta, Ga., with an expected attendance of 125. At the 1955 Summer General Meeting at Swampscott, Mass., this subcommittee presented its work of the last four or five years entitled "Recommended Practices for the Textile Industry." The schedule of this subcommittee now includes a program at the 1957 Summer General Meeting to be held in Montreal, Que., Canada.

The Rubber and Plastics Subcommittee held a two-day Conference at Akron, Ohio, in April 1955 with an attendance of 200, and its 1956 Conference was scheduled for April 9–10 at Akron. This subcommittee also has assigned subgroups to work on "Problems with Electric Equipment in Contaminated Atmospheres" and "Electrical Standardization in the Rubber and Plastics Industry."

The Material Handling Subcommittee sponsored a two-day Conference at Cleveland on March 28–29, 1955, with an attendance of 293. Their next is planned for the spring of 1957. There seems to be some difficulty in setting up Conferences each year. Therefore, it has been suggested that this subcommittee sponsor individual papers or a single session at Conferences sponsored by other subcommittees.

The Pacific Coast Subcommittee is now operating successfully having sponsored a session at the Pacific General Meeting in 1955, and it is now sponsoring a session at the Summer and Pacific General Meeting at San Francisco, Calif. Because of geographical difficulties it has been found best to have this subcommittee cover the entire industrial scene rather than restricting its activities to one particular segment of industry, such as machine tools, rubber and plastics, etc., which while successful on a national scale does not appear to be practical for the West Coast operation.

COMMITTEE ON INDUSTRIAL CONTROL

A meeting of the Committee on Industrial Control was held during the Winter General Meeting in February 1956. Two technical sessions were sponsored at this meeting. One of these sessions was concerned primarily with magnetic control and safety in industrial control, while the other was primarily concerned with electronic control.

Subcommittee on Test Codes. This group has submitted to the main Committee a number of sections of a proposed test code for industrial control equipment, and some of these sections have been accepted. Additional sections of this proposed code are being reviewed by the main Committee. It is expected that this test code will shortly be completed and will then be submitted to the appropriate body for adoption and for eventual printing.

Subcommittee on Electronic Control. This group has been very active during the past year preparing a standard for electronic motor controls. This work resulted in the presentation of a Conference Paper at the Winter General Meeting entitled "Report on Proposed Standard for Electronic D-C Motor Controllers." In addition to this work, the Subcommittee is active on a proposed standard for photoelectric controls.

Subcommittee on Regulators and Feedback Control Systems. This group operates as a liaison group with others active in preparing definitions in this field. During the past year, there has been co-operation with American Standards Association on *Y10* and *C85*.

COMMITTEE ON INDUSTRIAL POWER RECTIFIERS

The Committee sponsored two very successful technical meetings and held a committee meeting at the 1956 Winter General Meeting.

Administrative Subcommittee. This subcommittee met in September to formulate plans for the administrative year.

Electronic Converter Circuits Subcommittee. This group and the Working Group on Protection of Electronic Converters, are working on a number of projects. Report number 5545 on grounding practices is being revised. Work is in progress on harmonic curves and power factor curves. Further work is required before the report relative to the application of switch gear to rectifiers can be completed.

Mercury Arc Converter Subcommittee. This subcommittee is maintaining liaison with the National Electrical Manufacturers Association committee preparing standards for mill applications of rectifier equipments.

Mechanical Rectifier Subcommittee. This group has initiated preliminary work on standards for mechanical rectifiers. Terminology, nomenclature, definitions, and symbols are to be correlated with existing standards for mercury arc rectifiers, metallic rectifiers, and magnetic amplifiers.

West Coast Subcommittee. This subcommittee is sponsoring a technical session and will hold a committee meeting at the 1956 Summer and Pacific General Meeting.

Working Group on Revision of American Standard C34.1. This group expects to complete its assignment during this administrative year.

A Working Group has been appointed to submit recommendations specifying the detailed test procedures and requirements for test components for making arc-drop measurements.

Plans are being formulated by the respective co-chairmen from the Committee on Metallic Rectifiers and the Committee on Industrial Rectifiers for a Joint Conference in 1957.

COMMITTEE ON INDUSTRIAL POWER SYSTEMS

During 1955–1956, this Committee held two committee meetings as sponsors for independent sessions and cosponsors of two joint sessions.

An unusually large turnout at one of the sessions indicated the widespread interest in the field of Electric Systems for Commerical Buildings. The Subcommittee on Electric Systems for Commercial Buildings is currently preparing the "Gray Book" as a committee report and it is essentially a revision of what was formerly called the "Green Book" except that it is to be all-inclusive for the electric systems in commercial buildings. This is one of the companion publications of this Committee.

The Subcommittee on Electric Power Distribution for Industrial Plants has completed its work on the "Red Book" which will be published as a Committee report. This material has been submitted to the Standards Committee who will, after its approval, publish the data. A standing committee has been established to keep this "Red Book" publication up to date.

Another companion publication is the "Green Book" entitled "Grounding in Industrial Plants." This Committee report, as developed by the Subcommittee on Industrial Grounding, is awaiting approval and publication by the Standards Committee.

The publication of the "Green," "Gray," and "Red Book" has involved assignments of every member of the Committee, and it has been necessary to include others outside of the committee for the many details involved in the publications.

The Pacific Coast Subcommittee is continuing its efforts in the developing of technical sessions on the West Coast and is contributing in the increased relationship between members on the West Coast and others in the main Committee.

COMMITTEE ON MINING AND METAL INDUSTRY

The Metal Industries Subcommittee has been devoting attention toward "Power Systems for the Steel Industry" and "Automatic Control Systems in the Steel Industry." As a result, a technical session on power systems was presented at the 1956 Winter General Meeting and another is scheduled for the 1956 Summer and Pacific General Meeting. Also, for the latter meeting, a

session is being scheduled on automatic control systems.

The Eastern Mining Subcommittee is reviewing a report of the Conversion Substation Committee on the subject of Direct-Current Equipment Grounding Practices. Correlation of the report with underground mining requirements is intended.

Sessions on mining are being prepared for the Summer and Pacific General Meeting and for the Fall General Meeting, one session each.

COMMITTEE ON PETROLEUM INDUSTRY

The Committee has devoted a majority of its effort to establishment of an annual Special Technical Conference as a worthwhile meeting. The first two Conferences held in 1954 and 1955 proved very successful. The annual Special Technical Conference is becoming an important meeting and one which will be contributing considerably to the electrical engineering art in the petroleum industry.

Plans are being made for the 1957 and 1958 Conferences to be held in Philadelphia, Pa., and Dallas, Tex., respectively. A program similar to the one presented this year is contemplated for each of the succeeding Conferences with technical papers in all phases of the industry.

The committee also is planning sessions at general meetings and to consider standards for equipment and fixtures used in hazardous locations such as refineries, pumping stations, etc.

Power Division

COMMITTEE ON CARRIER CURRENT

The Committee sponsored technical sessions and held committee meetings at the Summer, Fall, and Winter General Meetings. At the Summer and the Winter General Meetings the emphasis was on microwave whereas the session at the Fall General Meeting was devoted to carrier current and relaying, and was sponsored jointly by these committees. A microwave symposium at the Winter General Meeting in which users informally presented items of general interest was very well attended with several interesting discussions from the floor.

With the growing use of microwave by the power industry, the Committee on Carrier Current intends to sponsor technical sessions which will emphasize microwave at the 1956 Summer and Pacific General and Fall General Meetings.

Executive Subcommittee. This subcommittee has the continuing function of assisting the chairman. It has prepared a revised scope and committee name. This has been approved by the main Committee on Carrier Current and submitted to the Power Division for their action.

Methods of Measurements Subcommittee. The members of this subcommittee are continuing to obtain data pertaining to the carrier characteristics of transmission lines, cables, and equipment. They have held several subcommittee meetings during the year and, although definite progress is being made, it will be several years before their work is completed.

Microwave Subcommittee. The Microwave Subcommittee continues to encourage technical papers on microwave. It sponsored the symposium at the Winter General Meeting and will continue to be extremely active. Its membership has recently been expanded and plans for the future include obtaining technical data on the performance of microwave installations.

Carrier Bibliography Subcommittee. This is a continuing activity to obtain a complete record of the literature on power line carrier and microwave. A new bibliography was presented, by title only, at the 1956 Winter General Meeting. This was a complete revision of the first bibliography and additions of literature which have appeared since the last report (1951).

Standards for Carrier Radiation. A report of this subcommittee was presented as a Conference Paper at the 1955 Fall General Meeting. Inasmuch as it does not appear practical to issue standards for carrier radiation at this time, this subcommittee will become inactive.

COMMITTEE ON INSULATED CONDUCTORS

During the year the Committee continued its activities through its 14 subcommittees. The newest of these, the Soil (Thermal) Resistivity Project Subcommittee started work on a three-year $65,000 co-operative research project sponsored by AIEE, Engineering Foundation, Edison Electric Institute, Association of Edison Illuminating Companies, Insulated Power Cable Engineers Association, certain governmental and municipal agencies, and a number of interested cable manufacturers in the United States and Canada. The investigation of thermal resistivity of soils has begun at Princeton University under the direction of Dr. H. F. Winterkorn. The first phase of this activity consists of outlining the nature of the problem of heat dissipation from pipe cable systems into soils, the nature of the soil environment and some of the fundamental principles of soil behavior under thermal conditions. A very extensive bibliography on "Thermal Conductivity and Diffusivity o Soils" and related subjects has been prepared. Dr. Winterkorn has submitted the First Semiannual Report of these activities to the Committee on Insulated Conductors.

The Subcommittee on Insulation has continued to explore the field of extra high voltage cables and is actively engaged in a search for insulating materials most suited for this purpose. This activity includes investigation of insulating paper tapes, impregnating oils, and synthetic tapes or other materials which may be used in the construction of higher voltage cables. The object of this study is to secure materials of sufficient dielectric strength, low power factor, and suitable mechanical characteristics for use in cables in the realm of voltages above those now in common use as well as to improve designs for present cables.

Work is being carried on by the Cable Characteristics Subcommittee to investigate the protection of aerial and buried cable from lightning. Increasing use of these cables and a number of failures from lightning make this a very important activity.

A study is being made to establish a definition of grounded and ungrounded systems in relation to cable insulation thickness requirements. This work should result in economies to those who are uncertain as to what insulation thickness to specify on systems which are grounded by resistance or reactance methods which fall between a solidly grounded and ungrounded system.

Work continues in the field of aluminum cable sheaths and protective coverings for them. The use of aluminum for cable sheaths is increasing and many investigations connected wth their operation must be conducted to determine such factors as permissible bending radii and necessary manhole sizes to provide trouble-free service. Studies are also being continued on minimum permissible lead thicknesses for use with protective jackets.

The use of buried cables for distribution is being reviewed in the light of United States and European practices. Although a duct type of cable system is undoubtedly best suited for heavy density load areas, there are some applications such as residential developments where buried cables may find application on an increased scale. Part of this investigation will relate operating reliability to depth of burial.

High-pressure gas filled pipe type 69-kv cables are now being installed on one system for distribution purposes. One unique feature is the development of a T joint for tapping these cables.

The use of higher temperature rubbers and rubber-like insulations for utilization purposes, as well as the use of aluminum for conductors, aluminum sheathed wires where the sheath would act as a neutral conductor, and the use of bare neutrals are being investigated.

Effective liaison with European cable engineers has been maintained during the year through the European Practice Subcommittee. One paper in particular was presented to the Institute which is considered outstanding in the field of high-voltage cable insulation research. A number of papers from European sources were circulated to the Insulated Conductors Committee which furnished minutes of its meetings and copies of AIEE papers to members of the subcommittee.

COMMITTEE ON POWER GENERATION

In addition to a number of subcommittee meetings, three committee meetings were held during the year, one at each General Meeting, at all of which technical sessions were sponsored. Technical sessions covered developments in the areas of excitation systems, plant auxiliaries, integrated steam station protection and control, hydroelectric systems, and operation of nuclear power plants.

No changes were made in the committee and subcommittee scopes as these had been thoroughly reviewed the previous year. Committee activities have been directed toward improved and longer range planning for future technical activities in view of rapidly expanding advances in the field of power generation.

Prime Movers Control and Protection Subcommittee. This reorganized subcommittee is examining the areas wherein activity is desirable and wherein liaison with other groups is required. Its working group on steam station protection presented a constructive paper at Chicago, Ill., as a starting basis for development of a basic philosophy of protection for an over-all integrated steam plant, and it is expected this work will be extended.

Subcommittee on Plant Design. An outstanding study of problems associated with fire protection for generating stations was thoroughly reviewed. After editing, it is anticipated this will be presented at a future General Meeting and become a special publication. Sessions planned include a re-evaluation of recent power plants with emphasis on the electric circuits, indoor versus outdoor power plants, problems associated with extra large units, and supercritical pressures.

Excitation Systems Subcommittee. Considerable work on excitation system response has been done but the working group has not yet been able to agree on a satisfactory definition, a situation causing confusion in the industry. Plans are in hand to complete this investigation at an early date.

Hydroelectric Systems Subcommittee. This subcommittee has been active, especially the working group on operating and maintenance experience with thrust bearings for large hydroelectric units. It is anticipated returns to a questionnaire will have been analyzed in time for a constructive presentation at the 1957 Winter General Meeting.

Application of Probability Methods Subcommittee. This subcommittee, a joint activity with System Engineering and Transmission and Distribution Committees, has been delayed in its analysis of forced outage rates for turbines and boilers because of difficulties arising from changes in the form of reporting data. Close liaison with Edison Electric Institute is being maintained, and a fruitful outcome of valuable findings is anticipated.

Joint AIEE-ASME Subcommittee on Recommended Specifications for the Speed Governing of Prime Movers. Changes in recommendations as to "maximum guaranteed capability" relative to "rated capacity" are under review but completion is dependent on test work by the manufacturers. Specifications for internal combustion engines have been reviewed and useful suggestions made, so that a tangible outcome in the near future is envisaged.

COMMITTEE ON PROTECTIVE DEVICES

Preparation and revision of standards relating to neutral grounding devices and lightning arresters has been the major activity of the Committee on Protective Devices during fiscal 1955–56. In addition, working groups have also been active in studying problems associated with these standards. Various papers sponsored by the Committee on Protective Devices were presented at the Fall, Winter, and Summer General Meetings.

Fault Limiting Devices Subcommittee. The working group engaged in revising AIEE Standard No. 32 on Neutral Grounding Devices has made progress. One of the most difficult problems has been to determine the method to be included in the standard for calculation of temperature raise during short circuits. A method conforming with the transformer standards is under consideration. When finally completed, it is expected that the revised standard will be submitted to the ASA for approval.

The subcommittee proposes to investigate the operating practice where generators are equipped with the distribution transformer—secondary resistor combination for neutral grounding. This combination is used on unit generators supplying delta windings of step-up power transformers. The "Application Guide for the Grounding of Synchronous Generating Systems" recommends that when this method of neutral grounding is used the generator should be tripped automatically when a ground fault develops. Some utilities are not following this practice. They use an alarm relay and keep the generator in operation until additional generation can be brought into service and then take the faulted generator off by hand. Inasmuch as the fault current is of the order of only about 10 amperes, it would appear that this could be done without excessive burning of the generator core or other material located at the fault. Other utilities use instantaneous tripping but the operators object to it. It is the intention of the subcommittee to look into this problem, evaluate the factors and make recommendations.

Lightning Protective Devices Subcommittee. The AIEE report on Standards for Valve and Expulsion Type Lightning Arresters has been approved by the Standards Committee and has been published as AIEE Standard No. 28B. The American Standards Association Sectional Committee *C-62* is using this and the National Electrical Manufacturers Association Lightning Arrester Standard as a basis for formulating a new American Standard for Lightning Arresters.

A working group has been organized to study surge protection of dry type power transformers. Most of the dry type power transformers are used on industrial and power house circuits where lightning surges are normally not a problem. However, some dry type transformers are directly connected to overhead lines exposed to lightning, and here there is the problem of educating the users to the necessity for lightning protection.

The working group on surge protection of aerial cable has prepared a questionnaire which is now ready to go to the users. Preliminary discussions have disclosed that: (a) causes of service failures are not too obvious, (b) multiple punctures of cable insulation has occurred, (c) the cable impulse strength is generally high, (d) sheath practice varies widely, and (e) some users provide lightning arresters for the cables but others do not.

The results of the questionnaire should provide material for an AIEE paper on this subject.

Work on the "Lightning Arrester Application Guide" is progressing. The approval of the Lightning Arrester report has clarified the situation and the working group expects to have a final guide available for presentation to the AIEE early next Fall.

A working group has been organized to study the lightning and surge protection required for multicircuit substations. One of the objectives is to determine typical substation configurations and prepare recommendations on the basis of the typical layouts. A number of studies on protection of multiline substations have been made both in the field and in miniature. A graphic method or principle for evaluating the effect of nonstandard waves on insulation is under consideration and work is continuing on this subject.

A working group has been organized to study surge transfer through transformers. Another project under consideration is a study of the benefits to be derived from the use of lightning arresters in parallel. The expected benefit would be the reduction in discharge voltage by cutting the current in half for very high surge currents. Additional test data is desired.

Co-ordination of Insulation Subcommittee. This subcommittee functions in a liaison capacity between the Protective Devices Committee and AIEE Standards Co-ordinating Committee No. 8. Data has been prepared by the Lightning Protective Devices Subcommittee on performance characteristics of valve type lightning arresters and was submitted to Standards Co-ordinating Committee No. 8. This data is to be used for preliminary studies only pending publication of final authorized data. This data was furnished without benefit of official sanction of the Committee on Protective Devices, and a working group is being organized to review continuously the data as supplied by the manufacturers and revise as required. Committee No. 8 will study use of this data as to the effect of the lower discharge voltages of valve type lightning arresters on the establishment of standard basic impulse insulation levels.

COMMITTEE ON RELAYS

Consistent with the practice of the Committee on Relays during the past several years, this group has held three meetings during the AIEE fiscal year. A half-day meeting of the main committee was held as usual in New York during the Winter General Meeting. The two-day Spring and Fall sessions simplify meeting arrangements for the various subcommittees and project committees, and facilitate active liaison between them and the main committee, which holds a plenary session on the second day.

A new Subcommittee on Transformer Protection has been established, to study practices in this field and review the effectiveness of existing and proposed methods of transformer relaying.

Two project committees, having completed their assignments were discharged. The Project Committee on Devices for Control of Load Shedding and System Separation presented its report at the Pacific General Meeting. It is expected that work along these lines may be resumed in the future, after more industry experience with load shedding accumulates. The Project Committee on Test Methods presented its report at the Winter General Meeting and extensive interest was shown. The wide variety of practices in this area emphasizes the value of an industry-wide study in an attempt to single out the most effective test procedures.

Other activities of the committee that are still in progress, include the continuing compilation of the "Bibliography of Relay Literature" and extensive work in extending and up-dating relay standards. Specific reports in both these fields are expected to be forthcoming in the near future. Work is likewise progressing on the survey of relay protective practices in the United States and Canada, which was started last year under a new project committee. The Project Committee on Motor Protection has been particularly active, sponsoring numerous papers that were presented during the year and working in contact with other AIEE committees having allied interests.

COMMITTEE ON ROTATING MACHINERY

As is usual in this committee, the preparation and revision of rotating machine standards continued to be the major activity during 1955–56. Two standards have been submitted for Standards Committee approval and three more probably will be submitted before the end of the fiscal year. In order to provide better co-ordination for this activity the Test Code Subcommittee and the Working Group on American Standards will be combined as the Standards and Test Code Subcommittee next year.

We have successfully continued our efforts to divert technical sessions to the Fall General Meeting and now have our Winter General Meeting program down to a reasonable size. We have not met any significant author resistance to this change in programming.

Synchronous Machinery Subcommittee. The proposed "Guide for Operation and Maintenance of Turbine-Generators" has been revised in accordance with suggestions from subcommittee members and has now been submitted to the subcommittee for approval by letter ballot.

The working group for revision of the "Test Code for Synchronous Machines," AIEE Standard 503, has substantially completed revision of this code with the exception of certain additional modifications which might result from the recently assigned project to determine definitions and tests for reactance values more exactly related to their uses.

Induction Machinery Subcommittee. This subcommittee is considering several standards projects, most of them concerning test methods, but it will be necessary to develop more information, probably through technical sessions, before definite assignments can be made.

Direct-Current Machinery Subcommittee. The proposed revision of the "Test Code for D-C Machines," AIEE Standard 501, has been approved by the subcommittee. After making some editorial revisions suggested by the Test Code Subcommittee it will be ready for consideration by the Committee on Rotating Machinery.

The Working Group on a "Guide for Short Circuit Calculations" has completed its assignment and the proposed guide will be considered at the next Administrative Subcommittee meeting.

Single-Phase and Fractional-Horsepower Machinery Subcommittee. This subcommittee was cosponsor with the St. Louis Section of a Special Technical Conference on the Application of Small Motors last Fall and is planning the fourth of a series of Conferences with the Dayton Section probably in 1957.

A revision of the "Test Code for Single-Phase Motors," AIEE Standard 502, has been submitted to the Committee on Rotating Machinery for approval by letter ballot. When approved as an AIEE Standard it is planned to submit this to American Standards Association Sectional Committee *C50* for inclusion in the American Standard for Rotating Machines.

Electric Coupling Subcommittee. At present there are no recognized standards for this type of machine. This subcommittee has just appointed three working groups to prepare (1) definitions, (2) standards of rating and performance, and (3) a test code.

Insulation Subcommittee. A revision of the "Test Procedure for Evaluation of Systems of Insulating Materials for Random-Wound Electric Machinery," AIEE Standard 1C, and a proposed "Test Procedure for Evaluation of Systems of Insulating Materials for Rotating Electric Machinery Employing Form-Wound Preinsulated Coils (Machines rated at 50 to 2,000 hp and below 6,600 v)" have been approved by the committee and recommended to the Standards Committee.

A revision of the "Guide for Insulation Maintenance for Large Alternating-Current Rotating Machinery," AIEE Standard 56, has been completed and has been submitted to the committee for approval by letter ballot.

The working group which is preparing a "Test Procedure for Evaluation of Insulation Systems for High-Voltage Rotating Machines" is making satisfactory progress. A new working group has been appointed to review and possibly revise "Recommended Practice for Testing Insulation Resistance of Rotating Machinery," AIEE Standard 43, and another working group has been appointed to investigate the usefulness of a possible "Test Procedure for Evaluation of Hermetic Refrigerator Motor Insulation Systems."

Test Code Subcommittee. This subcommittee co-ordinates the test code activities of the other subcommittees. This year it has reviewed and approved two test codes but its major activity as usual was to aid and advise the working groups during the writing.

Publicity and Bibliography Subcommittee. Reports on committee activities appeared in *Electrical Engineering* and a report of "Engineering Developments for 1955" was prepared for the January 1956 issue.

Carbon Brush Subcommittee (Joint with Committee on Air Transportation and National Electrical Manufacturers Association).

A revision of the "Test Code for Carbon Brushes" prepared by this subcommittee has been approved by the committee and will be recommended to the Standards Committee if the other committees concur.

Working Groups.

1. *Per-Unit Definitions.* This group has held two meetings and may be able to agree on recommendations by next year.
2. *Letter Symbols for Induction Motor Quantities.* The "Proposed Standard for Induction Motor Letter Symbols," AIEE Standard 58, was published in January for trial use.
3. *American Standards.* This group has been relatively inactive this year.
4. *Measurement of Rotating Machine Noise.* This group has held several meetings and now has three subgroups preparing a first draft of a test code.

COMMITTEE ON SUBSTATIONS

The Committee on Substations sponsored a technical session at the 1956 Winter General Meeting and, in addition, provided one paper for the 1956 Great Lakes District Meeting. Also the committee conducted a round-table discussion on the subject, "Future Trends in Substations," at the 1955 Fall General Meeting in Chicago, Ill.

Transmission Substation Subcommittee. This subcommittee is continuing work on two projects that were undertaken previously and, in addition, is starting on a new project. These are as follows:

Extra High Voltage Substations. The Working Group on Extra High Voltage Substations has completed a bibliography on this subject and also has circulated a questionnaire among several of the users of extra high voltage equipment. The results will be presented in a paper at the 1956 Summer and Pacific General Meeting.

Fire Protection and Minimizing Fire Hazards. This working group has made considerable progress on their assignment and a report is expected from them in the near future.

Voltage Gradients in the Ground During Fault Conditions. This is a new working group that is being organized to study voltage gradients through the ground under fault conditions.

Distribution Substation Subcommittee. This subcommittee completed one project during the year and is continuing work on two additional projects.

Location and Design of Distribution Substations in Residential Areas. This working group completed their assignment and presented a paper giving the results of their work at the 1956 Winter General Meeting.

Design and Utilization of Mobile Substations. The working group on this project is preparing a report on the results of a questionnaire that was circulated among users of mobile substations. This report is expected to be available for a meeting in the near future.

Corrosion in Substation Grounding. The organization of this working group has been completed and it is now actively engaged in the study of this project.

Conversion Substation Subcommittee. The report of this subcommittee has been distributed to other interested AIEE committees for their review and comments. When these have been returned, the report will be issued by the subcommittee.

Automatic and Supervisory Control Subcommittee. The fifth draft of the revision of *C37.2* – 1945, "The American Standard for Automatic Station Control, Supervisory and Associated Telemetering Equipments," has been referred to the AIEE Standards Committee for approval. After this approval is obtained the draft will be forwarded to American Standards Association for their approval.

This subcommittee has formed a new working group to study the proper kinds and sizes of wire to use in supervisory equipments. It is expected that this working group will co-ordinate their efforts with National Electrical Manufacturers Association.

West Coast Subcommittee. This subcommittee held several meetings at various locations on the West Coast during the year. They have undertaken several projects for study and also have been active in

organizing a technical program for the 1956 Summer and Pacific General Meeting.

COMMITTEE ON SWITCHGEAR

The Committee on Switchgear, through the work of its subcommittees and working groups, has had a very active year.

The Committee has held two meetings, one at Niagara Falls, N. Y., and one at Hershey, Pa. The meetings, held separate from the General Meetings, are attended by some 60 members who are engaged exclusively with the problems of the committee. Reports of the subcommittees and working groups, who have had previous meetings, are received and acted upon.

AIEE Guide No. 955, "The Guide for Evaluating the Effect of Solar Radiation on Outdoor Metal-Clad Switchgear," has been published during the year.

A revision of AIEE Standard No. 50 has been approved by the committee and sent to ASA for approval as an American Standard.

The Committee has sponsored technical meetings at the Fall, Winter, and Summer General Meetings. Numerous papers have reflected the progress in switchgear.

Administrative Subcommittee. The Administrative Subcommittee has continued its work of co-ordinating the standards of the subcommittees. It has given particular attention to those standards that are being prepared to cover the switching of static condensers by various switchgear devices.

Switches, Fuses, and Insulator Subcommittee. The principal activity of the subcommittee during the past year was concerned with a revision of AIEE Standards 22 and 25. The proposed general revision of AIEE Standard 22 will include the following: (1) Completely new test section designed to meet present-day requirements and practice. (2) 60-cycle dew withstand voltages for indoor insulators and devices. (3) Definitions on load current, capacitor current, magnetizing current, and reduced voltage ratings for interrupter switches. (4) Requirement that short-time momentary current ratings be included on nameplates of air switches. (5) Guide for the operation and maintenance of disconnecting switches. (6) Guide for ice testing of disconnecting switches.

All of the foregoing items have received subcommittee approval. In addition, the subcommittee has under study further changes in AIEE Standard 22 involving addition of short-time ratings of switches and coverage of automatic grounding switches and capacitor switches. These will be included in the next revision if they can be completed in time.

The proposed general revision of AIEE Standard 25 on "Fuses Above 600 Volts" will include a complete new test section and a "Guide for the Operation and Maintenance of Fuses," both of which are about ready for final subcommittee action. A working group of the subcommittee is studying the addition of "Short-Time Ratings for Power Fuses."

Another working group is preparing an AIEE Standard on 250- and 600-volt cartridge fuses.

Power Circuit Breaker Subcommittee. During the past year, the Subcommittee on Power Circuit Breakers has had under consideration a "Proposed New Basis for Rating Power Circuit Breakers." A working group under the chairmanship of C. A. Woodrow had previously made a proposal for a new basis of rating, and a second working group under the chairmanship of R. L. Webb was asked to investigate thoroughly the application of this method of rating to actual field conditions. During the past year, Mr. Webb's working group completed their investigation and presented a written report which required some changes in the original proposal. The report of Mr. Webb's working group was approved and the working group discharged with thanks. Additional suggestions for changes in the method of rating were made to the Subcommittee on Power Circuit Breakers by the National Electrical Manufacturers Association (NEMA) Power Circuit Breaker Section.

In August, V. L. Cox, chairman of the ASA *C37* Committee on Switchgear, called a meeting which included the chairmen of all of the industry committees interested in this subject. His purpose was to determine the progress and status of the "Proposed New Method of Rating Power Circuit Breakers" and to determine whether or not it would be advisable for the American delegation to International Electrotechnical Commission (IEC) to present the proposed method at the 1956 IEC meeting. The conclusions of this meeting was that work had not progressed to the point where it should be presented to IEC, and that the working group should now be broadened to include a larger cross-section of interest. Mr. Bennett, chairman of the Power Circuit Breaker Subcommittee, appointed an enlarged working group containing very broad representation of the industry.

The assignment of this working group was to study not only the method of rating proposed by Mr. Woodrow's original working group, but also to consider any other methods proposed for rating power circuit breakers, whether new or a revision of the existing American Standard. Mr. Woodrow's expanded working group reviewed: (1) The history, objectives, and results of the original working group. (2) Copies of (a) NEMA suggestions of September 27, 1955, for revision of the Test Code, and (b) report of the Working Group on Application. (3) A suggestion from C. E. Asbury regarding another method of rating consisting of a revision of the existing method. Mr. Woodrow also appointed a task force consisting of: J. S. Ambrose, *Chairman;* C. E. Asbury; C. H. Hoffman; and W. F. Skeats to prepare a summary of the differences in philosophy of the two methods of rating proposed: Method 1, the symmetrical basis of rating as proposed in the November 1954 Report and as broadly modified by other activity since that time; and Method 2, the proposal by Commonwealth Associates covered by their memorandum of October 6th and presented by C. E. Asbury.

Mr. Woodrow also appointed a task force to revise the 1954 report of the working group to take into consideration all of the suggestions which had been made to the Power Circuit Breaker Subcommittee, the NEMA recommendations, and the work of Mr. Webb's Working Group on Application. This task force consists of: C. L. Killgore, *Chairman*; J. A. Elzi; J. H. Vivian; and R. L. Webb.

Low-Voltage Air Circuit Breaker Subcommittee. This subcommittee has three working groups engaged in (a) preparing a guide for the calculation of faults on d-c circuits, (b) preparing a standard, application guide, and test code for molded case breakers, and (c) preparing a standard on field discharge circuit breakers. Satisfactory progress is being made on each project.

The subcommittee is also considering the advisability of changing the basis of interrupting rating of low-voltage air circuit breakers and the desirability of revising AIEE Standard 20.

Automatic Circuit Recloser and Automatic Line Sectionalizers Subcommittee. The subcommittee completed its work on the revision of AIEE Standard No. 50 for "Automatic Circuit Reclosers and Automatic Line Sectionalizers." The revision was approved by the Standards Committee and has been transmitted for approval as an American Standard.

The Working Group on Standards for Capacitor Switches for A-C Distribution Systems has held several meetings in the past year. Several drafts of a proposed standard have been prepared and revised. It is expected that a final draft will be ready for submittal to the Switchgear Subcommittees and other interested parties at the time of the May meeting of the Committee on Switchgear.

Switchgear Assemblies Subcommittee. The present AIEE Standard No. 27 (ASA *C37.20*) has not required any revision during the year. Several subjects such as switchgear grounding, outdoor switchgear, application of ground detectors, and a new definition of load interruptor switching cubicle are being studied and may require revision in the near future.

COMMITTEE ON SYSTEM ENGINEERING

The Committee held four meetings during the past year. It sponsored technical sessions at the Summer, Fall, and Winter General Meetings. Several of these sessions were held jointly with the Committee on Computing Devices and also with the Committee on Power Generation. During the year, the Application of Computing Devices Subcommittee was organized to coordinate the increasing activities resulting from the use of computers for the solution of System Engineering problems. The Probability Subcommittee which is joint with the Power Generation Committee was expanded to include representatives from the Committee on Transmission and Distribution. The Far West Subcommittee which was organized in 1954 to provide a closer coordination with the Pacific Coast activities has been allowed to lapse and its functions have been replaced by a broader representation of Pacific Coast members on the subcommittees. The work of the committee is assigned to seven subcommittees.

System Controls Subcommittee. This group studies the development and application of automatic controls for the regulation of the tie lines and frequency of interconnected systems. The subcommittee works with the Power Generation Committee and the System Economics Subcommittee as the scope of this activity overlaps these other committees. The subcommittee is engaged

in the completion of a questionnaire covering the application of automatic load control equipment and is preparing session programs which will cover some new developments in automatic load control equipment.

System Economics Subcommittee. This group has been active in the development of procedures to evaluate line losses and the coordination of economic load scheduling for the operation of power systems. This work is closely co-ordinated with the System Controls Subcommittee. This subcommittee has also been active in the application of computing techniques for the solution of operating problems in conjunction with the Computer Application Subcommittee.

System Operations Subcommittee. This group is continuing work in the development of load dispatching procedures, the training, operation, and general problems of interconnected systems.

System Planning Subcommittee. This group is now completing a project report on the "Effect of Arc Furnaces on Power Systems" and is continuing work on planning practices, economics of generator sizes, load forecasting, and the use of computing devices in the solution of the aforementioned problems in conjunction with the Computer Application Subcommittee.

Probability Subcommittee. This group is a joint activity with the Power Generation Committee. The compilation of equipment outage statistics is being continued and it is intended to include data for additional system components in the near future.

Application of Computing Devices Subcommittee. The group was organized in 1955–1956. This subcommittee is actively engaged in preparing a group of session programs in conjunction with the Committee on Computers to educate the engineers in the economic use and limitations of various types of computers, to make available engineering problems which are pertinent to the Committee on System Engineering and by enlarging contacts with the Committee on Computers develop a greater variety of problems for analysis by computers.

Administrative Subcommittee. This group met in March to assist the chairman in the reorganization of the Committee for 1956–1957. The subcommittee will provide the means to discuss internal committee activities.

COMMITTEE ON TRANSFORMERS

The Committee held two meetings during the past year. It sponsored technical sessions at the Summer, Fall, and Winter General Meetings.

The work of the Committee is divided among seven subcommittees. Following is a report of the activities of these subcommittees.

Dielectric Tests Subcommittee. The work on Power Factor Test Codes is continuing with "Trial Use" editions approved and published for power and distribution transformers. Work has been started on a Code for oil-insulated instrument transformers.

Due to comments received in the Standards Committee, additional work is being done on the Tables of Standard Dielectric Tests for Dry-Type Transformers and Shunt Reactors, Instrument Transformers, and Step-Voltage and Induction Regulators.

A study has been started concerning the necessity of distribution and power levels for transformer equipment.

Considerable activity is under way on the subject of impulse testing. Two phases of the subject are under active study. One objective is to review the present Test Code and recommend needed changes; the other objective is to prepare a "Guide on Impulse Testing." It is hoped that the latter will serve to eliminate some of the misunderstandings that exist on this subject.

Work is being continued on the switching surge strength of insulation.

A new group has been activated to study the adequacy of present tests. The first assignment of this task force is to review the adequacy of the present dielectric tests for transformer bushings.

Insulation Life Subcommittee. This subcommittee is showing considerable progress in the preparation of formal "Test Procedures for Thermal Evaluation of Insulation Systems for Transformers." The procedure for ventilated dry type power and distribution transformers has been completed, approved by the Committee on Transformers, and submitted to the Standards Committee for publication as a Proposed Test Procedure for Trial Use. Procedures for sealed gas-filled transformers, for liquid-immersed transformers, and for specialty transformers are in various stages of development.

A proposed revision of the short-circuit sections of American Standard *C57*, which was submitted to American Standards Association (ASA) last year, failed to receive ASA approval. It has been referred back to the subcommittee for further study and revision.

A new proposal to revise and bring up to date the table of temperature rise limits for transformers has been approved and submitted to the Standards Committee.

Work is progressing satisfactorily on revising the "Guide for Loading Oil-Immersed Distribution and Power Transformers" (ASA designation: Appendix *C57.92*) and on preparing a new "Guide for Loading Dry Type Transformers."

Other items under consideration include methods for making temperature tests on dry type transformers, methods for measuring ambient temperatures, and a review of short-circuit requirements for step-voltage and induction-voltage regulators.

Insulating Fluids Subcommittee. The proposed "Guide for Maintenance of Insulating Oils" that was started about two years ago has been completed. This guide was approved by the Committee on Transformers and has been presented to the AIEE Standards Committee for its approval, and it is recommended that it be published for trial use.

In order to make this guide more useful to utilities and individuals, an industry questionnaire was prepared with the idea of collecting data concerning the methods of handling and tests used for insulating oils. The mechanics of sending this questionnaire to approximately 80 utilities is nearly completed. A summary of the data obtained in this questionnaire will be included in a revision that is expected to be made sometime next year.

Audible Sound Subcommittee. Organization of the subcommittee was completed in October 1955. A Working Group on Technical Investigations has been formed with the following responsibilities: (1) to continue the development of noise versus distance calculations, (2) to attempt a correlation of calculated noise-distance data with field data, (3) to investigate and develop the effects of external noise barriers and walls, (4) to study the use of windscreens as a possible means of co-ordinating readings between self-cooled and fan-cooled transformers, (5) to analyze available field data for the purpose of evaluating the sound levels likely to cause complaints, and (6) to study and recommend methods for taking field data.

It is anticipated that a Working Group on Field Investigations may be organized in the future to help conduct the collection of field data.

Liaison has been established with the Working Group on Noise Evaluation of the AIEE Committee on Rotating Machinery.

Performance Characteristics Subcommittee. Much of the activity formerly carried on by this subcommittee is now in the scope of the Standards Subcommittee.

A working group has been assigned to study the use of impedance bridge methods for loss measurements in transformer testing.

Standards Subcommittee. Eight working groups have been appointed, one on each of the following subjects: reactors, power and distribution transformers, instrument transformers, dry type transformers, rectifier transformers, constant current transformers, furnace transformers, and feeder voltage regulators.

These groups are preparing revisions for the standards. Some of them have had several meetings. Recommendations for use in the preparation of standards on each of the listed types of equipment will be submitted to the Transformer Committee in the coming year. The division of the transformer standards into several parts, each complete in itself and securing uniformity among the various standards significantly affects the assignments of these working groups.

The proposed "Guide for Operation and Maintenance of Dry Type Transformers" has been revised, and is about ready for final approval.

West Coast Subcommittee. This subcommittee does not have any specific projects but rather reviews and comments on the work on the main committee and the other subcommittees. Several projects in other subcommittees have been initiated at the suggestion of the West Coast group, and other activities have received an impetus because of West Coast interest.

This group assists in arranging technical papers for West Coast meetings.

At the meetings, which are held several times a year, the most active discussions have been on bushing tests, impulse testing, switching surges, and transformer noise and vibration.

COMMITTEE ON TRANSMISSION AND DISTRIBUTION

The Committee held two meetings during the year. It sponsored sessions at the Summer, Fall, and Winter General Meetings. Papers were also presented at several District Meetings.

Capacitor Subcommittee. A bibliography has been prepared covering the years 1953, 1954, and 1955. This is being put into form for issuance. Studies are well under way on the problem of short-time voltage characteristics of capacitors, and also of problems incident to the switching of capacitor banks. Studies are also being made for the ultimate revision and modernization of the AIEE Standard No. 18 (Power Capacitors.)

Distribution Subcommittee. The rapidly increasing loads have developed a strong interest in the use of higher voltage distribution. Studies have indicated that higher voltage can be justified under many conditions for secondary as well as primary distribution.

The shift to higher voltage in general, however, may be slow in built up communities because of high changeover costs. The present trend is to the use of a higher primary distribution voltage in the rural areas and new or fringe areas, and higher secondary voltages in the urban locations—especially for larger spot loads.

General Systems Subcommittee. Considerable work has been done by various working groups on such items as switching surges, fault locating methods, and arc deionization times for higher voltage circuits. A bibliography of recent literature on these subjects has been prepared.

A considerable part of this work has only been possible because of the development and use of analytical tools such as system analyzers, analogue computers, digital computers, etc. Significantly, as of today, the a-c network analyzer apparently has been the most useful and generally accepted of all the analytical tools developed thus far. Its growth is keeping pace with the development of the electric power industry. Also, the number of components required to handle studies of increasingly larger transmission and distribution systems is increasing.

Whereas system analyzers such as the a-c network analyzer have had an early start and a healthy growth in the area of system planning and system protection, it is only recently that such devices have been employed effectively in the area of system operation. Recent advances made in analyzing incremental transmission losses have resulted in combining the forces of the a-c network analyzer and the digital computer. In addition, several newly developed computers for evaluating incremental transmission line losses have been placed into operation within the past year.

Lightning and Insulator Subcommittee. Considerable information has been developed on the impulse characteristics of porcelain, wood, and air gaps in combination. The report of the working group investigating this matter was presented during the past year. This has been a definite contribution to the literature on this subject.

Work is continuing on the fundamentals involved in the design of transmission line insulation to avoid the effects of contaminated atmosphere. The use of silicones offers some promise but there is also a considerable amount of conflicting information on the subject which, as yet, has not been possible to evaluate satisfactorily.

A group has been formed with liaison representatives from other committees to study and report on the problem of radio and television interference. This is being actively pursued and will be of increasing importance as 330 kv transmission voltage gains wider acceptance.

A working group has also been established to review the operating experience under lightning conditions of double circuit transmission towers with single ground wires.

Towers, Poles, and Conductors Subcommittee. In the field of towers, poles, and conductors, there is increasing interest in bundled conductors for transmission circuits. These advantages are being further explored, together with the requirements which they impose on other elements of the transmission system. Among the more prominent of the latter are the strength requirements of the supporting structures, and the concomitant definition of broken wire conditions.

The strength of all transmission structures in relation to the loads which may be imposed on them has been receiving some attention, and efforts are being made to determine, by a questionnaire, the designers approach to the strength problem. Since broken wire assumptions play a very important part in the ultimate strength and weight of transmission structures, information is being gathered on the extent to which such assumptions are employed by the various utilities.

Considerable and continuing interest has been evidenced during the last year in the treatment and probable life of wood poles used on transmission and distribution lines. The effects of various types of treatment, the advantages of various woods, and the problems associated with soil conditions in different parts of the country have received detailed consideration.

The problem of corrosion of line hardware is also continuing to receive attention.

General. The committee is maintaining a very close liaison with the ASA Sectional Committee *C2* which is working on the current revision of the National Electrical Safety Code. This is concerned primarily with those lines exceeding 100-kv, and generally involves the matter of clearances. Considerable progress has been made. It is believed that a much improved basis for establishing rules on clearance matters will be forthcoming.

Science and Electronics Division

SCIENCE AND ELECTRONICS DIVISION COMMITTEE

The scope and emphasis of activities in the Science and Electronics Division Committee change rapidly because progress in this important area is fast and continuous. During the past year, the new Committees on Dielectrics and on Solid-State Devices have established effective and progressive programs. The careful reorganization of the Committee on Instruments and Measurements over a period of several years has culminated into the proposal that this committee be given Division status beginning in 1956–57. Additional subcommittees have been formed within the Science and Electronics Division and the Division has participated in the development of committees to develop areas of knowledge which are of interest to several divisions.

The development of technical programs by committee chairmen in the Science and Electronics Division have been characterized by the selection of papers of extremely high quality and the development of several new Special Technical Conferences as well as the effective continuation of several such Conferences that were established in the past.

COMMITTEE ON BASIC SCIENCES

The Committee on Basic Sciences continued its usual activity of processing papers and sponsoring technical sessions at General Meetings. Two changes have been made in the structure of the committee. The former Subcommittee on Dielectrics attained full committee status by action of the Board of Directors in June 1955. The other change consisted of the full activation of the newly formed West Coast Subcommittee.

Meetings of the committee held at the 1955 Fall General Meeting and the 1956 Winter General Meeting were attended by 12 and 22 persons, respectively. Technical sessions were sponsored at the Summer and Fall General Meetings in 1955 and the Winter General Meeting in 1956 in which 14 Conference papers and 19 Transactions papers were presented. This number of papers is considerably smaller than last year, but it should be pointed out that the scope of committee has been reduced by the formation of the Committee on Dielectrics as a separate committee. It should also be pointed out that papers have been kept on a high standard; a high percentage of submitted papers are rejected and returned to the authors for revision.

A matter of continuing concern to the committee is the apparent lack of interest as evidenced by small attendance at some of the technical sessions. It is felt that the Committee on Basic Sciences should do whatever is possible to further the interest of electrical engineers in the basic sciences. In some cases, the low attendance is due to conflicts with other sessions, and in the case of the Fall General Meeting there was serious conflict with the National Electronics Conference.

As one project for stimulating interest we have in progress a plan for sponsoring a series of articles in *Electrical Engineering* on "The Impact of Modern Physics on Electrical Engineering." This is an ambitious program which has been in progress for over a year and will still take some time because of the problem of rounding up suitable authors. Another plan for stimulating interest is for this committee to assist local Sections in procuring speakers on basic science subjects. Notice has been placed in *Electrical Engineering* to the effect that we are prepared to offer such a service.

Activities of the various subcommittees are as follows:

Subcommittee on Magnetics. A very successful Special Technical Conference at

Pittsburgh, Pa., in June 1955 was sponsored by this group in conjunction with the American Physical Society and the American Institute of Mining and Metallurgical Engineers. A similar Conference is planned for October 1956, to be held in Boston, Mass.

Subcommittee on Basic Concepts. Papers which do not fit into the scope of other committees have been reviewed by this group. The subcommittee has also performed another important function; that of acting as a clearing house for various controversies among individual AIEE members on basic technical questions. Discussions on two such matters, the definition of the electric field vector **E** and single-phase induction motor theory, are now being handled by members of this subcommittee.

Subcommittee on Circuit Theory. The bulk of papers submitted to the committee are processed by this group, and at least one technical session at each General Meeting is sponsored by it.

Subcommittee on Applied Mathematics. A reasonably large number of papers have been reviewed by this subcommittee, but most of them have been rejected and have not yet been presented.

Subcommittee on Semiconductors and Transistors. In addition to reviewing regularly submitted papers, one session was sponsored by this group at the 1955 Summer General Meeting. Much of the work formerly handled by this subcommittee is now handled by the newly formed Committee on Solid-State Devices.

West Coast Subcommittee. Most of the year was spent in getting organized and now has a membership of 12 persons. This subcommittee's first active participation has been in planning a session of invited papers for the 1956 Summer and Pacific General Meeting.

COMMITTEE ON COMPUTING DEVICES

The Committee on Computing Devices bears a major responsibility in informing the members of the AIEE of the status and progress of the computer industry and of the application of computing devices to various technical and operating problems. The Committee has made a concerted drive this past year in emphasizing to engineers in industry the many areas in which computers may be used to solve industrial problems. A number of joint sessions, among them sessions cosponsored by the Transformer, System Engineering, and Rotating Machinery Committees, have been held to further this education process. General sessions have also been held to point out the many areas in which computers can be used to aid in engineering design and operation.

To insure that the AIEE members are kept up to date on computer possibilities, an Applications Subcommittee has been formed. The scope of the subcommittee is the "treatment of all phases of the application of computers in which the dominant factors are the design, construction, selection, installation, and operation of computing and related devices," and "liaison with other Institute committees on computer applications."

An indication of the growing interest by AIEE members in computers is given by the fact that 58 technical and conference papers have been reviewed by the committee during the past 6 months.

The committee, acting for the AIEE, has continued to work actively with the Institute of Radio Engineers and the Association of Computing Machinery on the Joint Computer Committee (JCC). Two Joint Computer Conferences have been held during the year. One was held in Boston, Mass., November 7–9, 1955, the subject of which was "Business and Industrial Applications of Computers," and one was held in San Francisco, Calif., February 6–10, 1956, at which general computer topics were discussed. One of the important problems being studied at present by the JCC is the one of awakening interest in computers among high school students and of providing basic computer materials and instruction to high school science faculties. Other questions under consideration are: (1) the permanent organization and purpose of the JCC, (2) the desirability of holding an International Computer Conference, and (3) standardization.

With the increasing number of computing systems and the desirability of communicating between the systems, there will be a growing need for the standardization of peripheral equipment. A representative of this committee is following the standards work of the JCC and is also representing the committee on an AIEE Standards Committee Action Group.

Plans are under way for an Eastern JCC in December 1956 in New York, N. Y., and a Western JCC in Los Angeles, Calif., early in 1957.

A study of the organizational structure of the committee is continuing in order to insure the ability of the committee to fulfill its responsibilities to the Institute in this period of rapid expansion in the computing devices field.

COMMITTEE ON DIELECTRICS

The Committee on Dielectrics came into existence as a full committee in the Science and Electronics Division on August 1, 1955. It succeeds the former Subcommittee on Dielectrics of the Basic Sciences Committee. It now has five subcommittees, namely: Gaseous Dielectrics, Liquid Dielectrics, Solid Dielectrics, Thermal Evaluation of Insulation Materials, and Corona and Radiation Effects on Dielectrics. The organization of a West Coast Subcommittee is now under way. It will be the function of this subcommittee to represent the main committee and to sponsor sessions of papers at meetings of the Institute in the West Coast area. With the increasing importance of nuclear activities, it has been decided recently to separate the radiation effects portion of the Subcommittee on Corona and Radiation Effects on Dielectrics and form a separate Subcommittee on Radiation Effects on Dielectrics. Liaison representation will be maintained with the recently formed Subcommittee on Effects of Radiation on Materials Used in the Electrical Industry of the Nucleonics Committee.

The principal activity of the Committee so far has been the sponsoring of papers at Institute sessions. During the last Institute year, the Committee sponsored two sessions of papers at the Fall General Meeting and five sessions at the Winter General Meeting.

While all of the subcommittees have been engaged in sponsoring papers and sessions at Institute meetings, the Subcommittee on Thermal Evaluation of Insulating Materials has also undertaken a special activity. This involves the development of a series of test procedures for the thermal evaluation of insulating materials. The first of these, entitled "Test Procedure for Evaluation of the Thermal Stability of Enamelled Wire" issued in October 1955 as AIEE Publication No. 57. Other test procedures which are under development are for rectangular enamelled wire, fibrous covered magnet wire, varnishes, flexible sheet insulation, rigid sheet insulation, mica composites, and tubing and sleeving. In addition, this subcommittee has under development a guide for the preparation of test procedures for the thermal evaluation of insulating materials which will eventually become part of AIEE Standard No. 1. Another important function of this subcommittee is co-operation with AIEE Standards Co-ordinating Committee No. 4 which has been assigned the task of revising AIEE Standard No. 1.

COMMITTEE ON ELECTRICAL TECHNIQUES IN MEDICINE AND BIOLOGY

During 1955, this Committee sponsored jointly with the Institute of Radio Engineers and the Instrument Society of America, the Eighth Annual Conference on Electrical Techniques in Medicine and Biology, which was held in Washington, D. C., in November 1955. This Conference maintained the high technical standard of previous Conferences, in providing a common meeting ground for engineers and members of the medical and biological professions interested in common problems. Symposia dealing with angiocardiography, instrumentation for hearing, and general instrumentation in both research and clinical medicine were featured in this Conference. Field trips to Federal facilities where pertinent research is being done heightened the over-all interest.

The committee was able to sponsor a session of technical papers at the 1956 Winter General Meeting, with an encouraging response on the part of a goodly audience of interested participants. In past years, the lack of general interest on the part of Institute members in the field of this Committee had discouraged attempts to hold sessions during General Meetings, thus concentrating on the annual Special Technical Conferences. Plans are being formulated to provide program material of broader general interest to the members of the Institute at large, in order to augment the value of technical sessions sponsored by the Committee.

Developments during the year have led to a decision on the part of this committee to establish a subcommittee to explore the subject of air pollution which, because of its rapidly increasing importance, will undoubtedly involve the interests of many Institute members. It is felt that this Committee constitutes a suitable medium for exploration of this field on behalf of the Institute. A subcommittee, to become active during the coming year, has been established.

The committee has also designed a Subcommittee on X-Ray Engineering, to be merged with an existing Subcommittee on Industrial X-Rays of the Electronics Committee. This joint Subcommittee on X-Ray Engineering will cover broadly the field of X-ray tubes and apparatus and their application in both the medical and industrial fields.

Plans for the coming year include the Ninth Annual Conference on Electrical Techniques in Medicine and Biology, which is tentatively scheduled for early November, in New York, N. Y.

COMMITTEE ON ELECTRONICS

During the fiscal year ending April 30, 1956, the Committee on Electronics completed a considerable revamping of organizational structure and committee representation. Papers secured for technical presentation and other routine functions of the committee have increased. Technical activities of the committee have been covered from time to time in *Electrical Engineering* and will not be repeated in this report, rather, organizational problems and advances in the scope of the committee will be examined briefly.

A necessary emphasis on the national character of the Committee on Electronics has been effected with the establishment of four vice-chairmen, each representing a geographical division of the country. The dispersal of electronics growth throughout the country in recent years has made such representation vital to progress of the Committee, and each vice-chairman has been assigned responsibility for conduct of one of the four annual committee meetings (Winter, Spring, Summer, and Fall) in addition to other national assignments.

Attendance at our major committee meetings during the fiscal year has doubled despite increasing conflict with IRE functions in which membership of the Committee frequently play a dual role. The nature of this conflict and the present ability of the Committee to fulfill adequately the needs of AIEE membership in this field have been the subject of intensive self-evaluation since our present chairman's tenure began. The "Appraisal of AIEE" report served to confirm the convictions of the Committee on Electronics that remedial action in the electronics area must be expedited and, to this end, an executive planning group was established by the chairman "to examine structure, function, and performance of the Committee" and to make Committee meetings of maximum benefit to the membership. A survey of the membership was subsequently undertaken to establish a factual basis for decision and a report is in preparation for presentation to the Executive Planning Group at the forthcoming Summer and Pacific General Meeting in San Francisco, Calif. It is noteworthy that traditional subcommittee preferences in the field of electronics appear to have undergone considerable change in the results of this survey. The Committee would appear to have before it some very weighty decisions to reach in order to establish an active, responsible, and mature voice in the field of electronics. To avoid such decisions or to defer them for future action may well mean a default of possibly permanent nature to other professional groups active in this dynamic field of electrical engineering. The Committee has no intention of defaulting leadership in its established area of operations.

These are properly the following by survey preference, subcommittee scope, and title: (1) Education in Electronics, (2) Electronic Circuits and Systems, (3) Reliability and Quality Control, (4) Electron Tubes, (5) Hot Cathode Converters, (6) Ultrahigh Frequency and Microwave Transmission Line Devices, (7) Electronic Aids to Navigation, (8) Electrostatic Processes, (9) X-ray Engineering, and (10) Infrared and Optics.

Liaison functions and Prize Papers and Awards are not included in the survey.

Technical activity and participation in the Committee on Electronics has not necessarily been in proportion to the order suggested, and is expected to require a more extensive evaluation of membership desires.

COMMITTEE ON INSTRUMENTS AND MEASUREMENTS

Organization. The continuously growing scope of the Committee on Instruments and Measurements led three years ago to a reorganization of the committee in terms of group subcommittees. Within the last year, these group subcommittees have exercised autonomy with respect to papers reviewed and organization of sessions similar to technical committees of the Institute.

During the last year, a petition was addressed to the Board of Directors to convert the Committee on Instruments and Measurements into a Division on Instrumentation. This petition was submitted to the Division Committee of the Science and Electronics Division on January 31, 1956. With the favorable recommendation of the Division Committee, the Committee on Technical Operations in turn endorsed the petition for submission to the Board of Directors of the Institute. The Board in its meeting on April 3 created the new Division effective August 1, 1956.

Technical Conferences. In addition to conducting technical sessions within the frame of Institute meetings, the Committee on Instruments and Measurements participated actively in the program of the Tenth Annual Instrument Conference organized by the Instrument Society of America in Los Angeles, Calif., September 12–16, 1955, and in the First Nuclear Engineering and Science Congress held in Cleveland, Ohio, December 12–16, 1955. The committee has also actively contributed to the program of the Electronic Components Symposium, scheduled May 1–3 at Washington, D. C. The Committee is represented both on the Steering Committee and on the Technical Program Committee.

In addition, the Committee on Instruments and Measurements has organized a number of Special Technical Conferences in the field of interest of several of the group subcommittees, such as:

Group Subcommittee III completed a comprehensive and interesting program for the Recorders and Controllers Conference held April 26 and 27 in Boston, Mass. Cosponsorship has been invited from the Instrument Division of the ASME and the Instrument Society of America.

Group Subcommittee VI is preparing the National Telemetering Conference to be held at the Biltmore Hotel in Los Angeles, Calif., August 20 and 21. Co-operation with WESCON has been arranged. It is planned to have eight sessions with about 40 papers, including several sessions on data handling.

Group Subcommittee VII is preparing a special conference on Scintillation Counters to be held in Washington, D. C.

Standards. The American Standard for Electric Indicating Instruments, *C39.1*, 1951 has been revised and the new issue appeared in December 1955. The actual changes have been minor and more in the nature of clarifications of the various requirements.

The "Master Test Code for Electrical Measurements in Power Circuits," cosponsored by the American Society of Mechanical Engineers was approved by the Standards Committee of the Institute and was also published in December 1955.

A new "Test Guide for Making Dielectric Measurements in the Field" was approved by the Instruments and Measurements Committee and has been sent to the Standards Committee for final approval and distribution on a one-year trial basis.

The "Master Test Code for Rotary Speed Measurements" has been distributed to the main committee for comments and possible approval.

COMMITTEE ON MAGNETIC AMPLIFIERS

The activity and interest within the scope of this Committee continues to expand. An indication of this was had when more than 540 persons registered to attend the first Special Technical Conference and Exhibit on Magnetic Amplifiers held on April 5–6, 1956, in Syracuse, N. Y. Four technical sessions were held during this Conference. The 19 papers presented at the Conference were selected from about 40 abstracts submitted for consideration. This Conference was cosponsored by the AIEE, IRE, and ISA.

This Committee's Dielectric Amplifier Subcommittee and its activities were transferred to the newly formed Committee on Solid-State Devices.

During the year, this Committee held three meetings and sponsored a number of technical sessions at the Summer and Winter General Meetings.

West Coast Subcommittee. This group sponsored one session at the Pacific General Meeting in Butte, Mont. It has also stimulated submission of and screened papers for the 1956 Summer and Pacific General Meeting.

Applications Subcommittee. This group sponsored one session at the 1955 National Electronics Conference. This subcommittee is preparing a bibliography in magnetic amplifiers to supplement the last such bibliography published in 1951.

Definitions Subcommittee. This group is about to issue a new progress report with revisions in definitions based upon the results of an Opinion Questionnaire circulated last year. Approval of these definitions by the main committee probably will be voted upon at the next committee meeting.

Standards Subcommittee. This group has continued its efforts to prepare standards for magnetic amplifiers. A working group on test codes has prepared preliminary proposals of methods for measuring (1) response time, (2) drift and zero stability, and (3) voltage and current amplifications.

Magnetic-Amplifier Theory Subcommittee. This group is actively promoting the theoretical aspects of magnetic amplifiers and related nonlinear devices. To this end, one project of the subcommittee is that of compiling a list of suitable thesis projects for college students. These thesis projects are to be characterized by (1) high academic content, (2) practical importance, (3) good

probability for finding solution, and (4) project solution not existing or not published.

Materials Subcommittee. Through two of its working groups, this subcommittee has continued efforts to provide and recommend useful and acceptable methods of (1) determining and presenting the magnetic materials characteristics and (2) grading and matching cores for magnetic amplifiers pertinent to magnetic-amplifiers usage. The working group on toroidal core size standardization is still seeking a solution of this very difficult problem.

COMMITTEE ON METALLIC RECTIFIERS

The area within the scope of this Committee continues to be very active, and because of the wide field of application of these rectifying devices, its work has been of keen interest to other committees.

Metallic rectifiers are solid-state devices and have been in existence under various forms for over 125 years. The introduction of the transistor, that is a metallic rectifier with a control electrode, has resulted in other AIEE committees and also outside organizations such as IRE, RETMA, and JETEC setting up activities which somewhat parallel the work of this Committee and the need of integration of objectives is urgent.

To emphasize the point that a metallic rectifier is a solid-state device, it is proposed to change the name of this Committee to Committee on Semiconductor Rectifiers.

The work of this Committee is ably handled by 10 subcommittees with over 50 participants and a minimum of two meetings per year.

Two formal reports are now in preparation, one "Metallic Rectifier Standards" and the other "Bibliography on Metallic Rectifier Patents." These will be issued shortly and placed on sale before the end of this AIEE fiscal year.

This Committee has participated in the work of the IEC in formulating international standards with two members attending the conference in England last June.

The Committee sponsored a well-attended technical session during the Winter General Meeting and also is making arrangements in collaboration with the Committee on Industrial Power Rectifiers for a joint conference on rectifiers next year.

It is anticipated that the 1956–57 Institute year will witness a steady increase in the activities of this Committee because of the widely expanding use of metallic rectifiers in all types of control circuits in addition to power supplies for converting alternating current to direct current.

The subcommittees are being reorganized in an attempt to obtain a good turnover in their membership.

COMMITTEE ON NUCLEONICS

The principal effort during the past year was directed toward support of the Cleveland Nuclear Engineering and Science Congress held in December. This meeting was sponsored by 26 engineering and scientific societies under the general aegis of the Engineers Joint Council, of which AIEE is a founding member. The Committee on Nucleonics supplied two members to the EJC Nuclear Congress Program Committee and all subcommittees contributed papers. Of 21 papers entered under AIEE sponsorship, 13 were included in the final program after eliminations because of duplication of subject matter with other societies participating. Four of the 13 AIEE papers have been approved recently for *Electrical Engineering*. The Cleveland Congress was highly successful and well attended. A commercial exhibit was sponsored in the Cleveland Auditorium by AIChE during the five days of technical meetings.

AIEE has been represented since on a policy committee organizing a similar joint technical society meeting on nuclear sciences. This is tentatively scheduled for March 10–16, 1957. The technical program would again be under the general sponsorship of EJC, with an operating management of AIEE and four other major engineering societies.

The United Nations Atoms for Peace Conference in Geneva, Switzerland, in August 1955 was attended by several members including the chairman of the Committee for Nucleonics.

The Committee held a meeting at Cleveland in December and finalized the co-ordination of the Instrumentation Subcommittee with the Instruments and Measurements Subcommittee on Nuclear and Radiation Measurements. The activities of the two subcommittees have been consolidated as a joint subcommittee. Membership of the Committee on Nucleonics is concerned principally with new developments and fundamental nuclear measurement concepts, while the Instruments and Measurements membership is concerned with instruments as devices and applied nuclear measuring techniques.

The Committee appointed a representative to the ASA-sponsored national conference on standardization for nuclear power, which held its first meeting in Washington, D. C., on December 8th.

The Committee met at the Winter General Meeting in New York, N. Y., and took definitive steps to rewrite the exceptionally successful 11-paper volume reprinted in 1949 from *Electrical Engineering* entitled "Elements of Nucleonics for Engineers." Because of rapid progress in the art and major declassification, this volume is now quite out of date and incomplete. Nevertheless, its function and the fact that it is still in general use attests to its value and the desirability of revision.

A new Subcommittee on "Effects of Radiation on Materials Used in the Electrical Industry" has been established. Its scope has been written so as to minimize overlap as far as practicable with the Committee on Dielectrics' Subcommittee on Effects of Radiation on Dielectrics.

Plans are progressing for participation in the 1956 Summer and Pacific General Meeting in San Francisco, Calif., through sponsorship of one or more half-day sessions of conference papers on reactor technology. The Subcommittee on Reactors and the West Coast Subcommittee are co-operating in the arrangements for these presentations.

COMMITTEE ON SOLID-STATE DEVICES

This committee was formally activated in the summer of 1955 and the major effort since then has been directed toward proper organization to implement its assigned functions. Since the devices of concern to the committee are widely used both in radio communication and in industrial electronics, it was decided to operate all subcommittees jointly with similar IRE groups. To this end, some members of the AIEE Committee joined with members of IRE to institute an IRE committee with a charter identical to that of the Committee on Solid-State Devices. Subcommittee scopes were then agreed upon and joint subcommittees were organized to cover the field. To avoid unnecessary meetings, and to bring the greatest diversity of talent together for consideration of technical committee problems, an experiment has been conducted involving simultaneous meetings of the two committees. Thus, the AIEE Committee on Solid-State Devices and the IRE Committee No. 28 meet at the same time and in the same room for discussions of technical matters and such "paper procurement" problems as may apply to jointly sponsored conferences. To date, this method of conducting committee affairs has been eminently satisfactory. Rarely has it been necessary to devote more than from 5 to 10 minutes at such simultaneous meetings to specific IRE or AIEE affairs, and the approval of proposed standards and organization of special conferences has been greatly expedited. It should be understood, however, that we do not consider this as a joint committee; each committee retains complete autonomy.

Joint Subcommittee on Semiconductor Devices—AIEE-IRE 28.4. This group has supported several technical sessions at AIEE meetings and organized the Semiconductor Research Conference held at the University of Pennsylvania last June. This subcommittee has completed three more sections of its "Standards for Semiconductor Devices." This work, in addition to those sections previously approved, has been submitted to the IRE Standards Committee who have approved two sections to date. With the recent agreement by the AIEE Standards Committee to consider for approval sections of standards which can be considered complete in themselves, all of this material has been submitted to that body for action.

Joint Subcommittee on Dielectric Devices—AIEE-IRE 28.5. This subcommittee, only recently completely organized, has sponsored one technical session and is conducting a survey of the technical field to permit preparation of an outline of the necessary standardization effort.

Joint Subcommittee on Magnetic Devices—AIEE-IRE 28.6. This subcommittee likewise is preparing an outline of desirable standardization work and is investigating the need of a jointly sponsored symposium on solid-state devices for the year 1957.

AWARDS

EDISON MEDAL

The Edison Medal for 1955 was awarded to L. A. Umansky (retired), engineering manager, Industrial Engineering Division, General Electric Company, ". . . for his outstanding contribution to the electrification of industry through the application of electrical machines, devices, and systems to automatic

process machinery; and for his inspiration, leadership, and teaching of men in this work," and was presented to him on January 31, 1956, during the Winter General Meeting.

The medal may be awarded annually for meritorious achievement in electrical science, electrical engineering, or the electrical arts. Awards are made by a committee of 21 members of the Institute.

LAMME MEDAL

The Lamme Medal for 1955 was awarded to C. R. Hanna, associate director of research, Westinghouse Electric Corporation, East Pittsburgh, Pa., ". . . for his fundamental calculations and developments in the field of electrodynamics and particularly for his achievements in the design of generator voltage regulators, automatic rolling mill controls, and tank gun stabilizers." The medal will be presented to him on June 25, 1956, at the Summer General Meeting.

The medal may be awarded annually by a committee of nine members to a member of the AIEE for "meritorious achievement in the development of electric apparatus or machinery."

CHARLES LeGEYT FORTESCUE FELLOWSHIP

The availability of this award was announced to the department heads of electrical engineering in all colleges in the country that offer accredited programs. After reviewing financial statements, the committee decided to award two fellowships for the academic year 1956–57, each to carry a stipend of $2,000. Sixty applications were received. Most applicants appeared to be well qualified for graduate level work.

The recipients for the award for the coming year are: D. F. Fox and K. F. Steffan. Mr. Fox is completing his bachelor of science degree at the University of Pittsburgh and will start the first year of his doctorate at the same institution this fall. Mr. Steffan is completing his bachelor of science degree at the Missouri School of Mines.

JOHN FRITZ MEDAL

The John Fritz Medal may be awarded annually for notable scientific or industrial achievements by a board of award composed of representatives of the American Society of Civil Engineers (ASCE), American Society of Mechanical Engineers (ASME), American Institute of Mining and Metallurgical Engineers (AIME), and AIEE. The 1956 medal was awarded to Philip Sporn, president, American Gas and Electric Company, New York, N. Y. with a citation, "Distinguished engineer, pioneer in utility engineering practice, eminent executive, human administrator."

The medal was presented to him on November 17, 1955, at a joint Honors Luncheon during the ASME meeting at the Conrad Hilton Hotel in Chicago, Ill.

HOOVER MEDAL

At the usual annual meeting of the Hoover Medal Board of Award, held in May 1955, the 1955 medal was awarded to C. F. Kettering, retired, research director of the General Motors Corporation and famous inventor, with the citation: "Scientist, engineer, inventor, philosopher, organizer of scientific efforts, developer of engineering devices and techniques, leader of industrial research, whose ideals and accomplishments have been inspirations to men of many countries."

Both the annual meeting and the award dinner meeting in Chicago, Ill., were attended by representatives of the Institute. During the past year, additional funds have been made available for this medal and it is hoped that the Board of Award may place the award on a more nearly annual basis.

MARSTON MEDAL BOARD OF AWARD

The Marston Medal for 1956 was awarded to J. O. Jackson, civil engineer, who has done much research in the field of reinforcing steel and in the design of a supersonic wind tunnel.

He is vice-president in charge of engineering and research of the Des Moines–Pittsburg Steel Company.

ALESSANDRO VOLTA MEMORIAL FUND

The successful candidate for this year's award of the Alessandro Volta Fellowship is Giuseppe Biorci of Genoa, Italy. Mr. Biorci graduated in 1953 from the University of Genoa and was subsequently engaged in research work at the National Electrotechnical Institute "Galileo Ferraris" in Turin, Italy, one of the most important electrotechnical laboratories in Italy.

Mr. Biorci has been appointed a research associate by the Massachusetts Institute of Technology for the year 1955–56. He is carrying on basic researches on ferromagnetism in the laboratory of Professor von Hippel.

During the Winter General Meeting in New York, N. Y., the President of the Institute gave a luncheon at which Mr. Biorci was the guest of honor. The luncheon was attended by Trustees of the Volta Memorial Fund, members of the Institute, a representative of the Italian Consul General in New York, and other distinguished guests.

The Board of Directors has approved recommendations of the Volta Memorial Trustees that steps be taken to raise additional money for the Fund. The Volta Trustees are proceeding accordingly with the hope of being able to continue for a longer period and to extend the very worth-while and effective results which are flowing from the operation of this memorial.

WASHINGTON AWARD

The Washington Award is conferred on one who, through accomplishment in engineering, has made pre-eminent contribution to the welfare of mankind.

The Award is administered by the Western Society of Engineers on the recommendation of a Commission representing the AIEE, ASCE, AIME, ASME, and the Western Society of Engineers.

Several meetings of the Commission were held and balloting instituted to select a candidate for the 1956 award. Dr. R. E. Wilson, chairman of the board, Standard Oil Company of Indiana, received the necessary two-thirds vote of the members of the Commission, and was therefore selected to receive the award for 1956. Dr. Wilson signified his acceptance of the award which was presented to him at a dinner meeting held jointly by the participating societies, May 1, 1956, at the Furniture Club of America, Chicago, Ill.

JOINT ACTIVITIES

UNITED ENGINEERING TRUSTEES

On June 8, 1955, 21 of the leading industrialists and educators of the country addressed to United Engineering Trustees (UET), the four Founder Societies, and the American Institute of Chemical Engineers, an offer to organize a national committee to conduct a drive for funds for a new Engineering Headquarters Building, and suggested a broad-gauged approach to the selection of the most suitable location for such headquarters. Subsequently the four Founder Societies and AIChE organized a Special Task Committee which engaged professional consultants to make a study of locations. It is expected that the recommendation of the Special Task Committee will be presented to the five societies at about the time this present report is published.

Due to the age of the present building, maintenance has become a serious problem. In the four months' period ending February 21, 1956, special appropriations of almost $16,000 were necessary for emergency and unusual repairs and replacements, and it is expected that heavy expenses will continue to be experienced as long as we must continue to occupy the present building.

Anticipating the retirement in the near future of J. H. R. Arms, secretary-general manager, the Trustees have engaged S. W. Marras to act as his assistant commencing August 1, 1956. Mr. Marras is presently with the Association of American Railroads in Chicago, Ill.

During the year, at the suggestion of UET, the four Founder Societies established an exploratory group to study the existing pension plans of the five organizations with a view to determining the practicability and possible advantages of either making provision for continuity of pension rights upon transfer of employment from one society to another, or setting up a single retirement system to cover the employees of all five organizations. This study is still in progress.

Engineering Societies' Library. A department of UET, the Engineering Societies' Library during the year ending September 30, 1955, experienced a net growth of 2,417 volumes, maps, etc., bringing the total to 194,962 items. There was, likewise, a substantial increase in the number of people served, books loaned, photoprints, translations, etc. Words translated increased 63 per cent over the previous year. For the first time in 24 years, an inventory was taken of all books in the Library. The income and cost of operating the Library amounted to approximately $140,000.

Engineering Foundation. A department of UET, the Engineering Foundation continued its work of stimulation of research during the year. The final budget for the fiscal year 1955–56 showed a total appropriation of $70,350 for the support of 29 projects. Money contributed by others to these projects will increase this amount to nearly a half million dollars for worthwhile engineering research. There are three projects sponsored by AIEE, namely: (a) Wood Pole Research; (b) High-Voltage, High-Frequency Dielectric Phenomena; and (c) Thermal Resistivity Characteristics of Soils.

ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

The Engineers' Council for Professional Development has been particularly active this year and AIEE members have played important roles in this activity.

The Annual Meeting of the Council was held in Toronto, Ont., Canada. This meeting was attended by official AIEE representatives and also by President Morris Hooven who was on the meeting program.

The Education Committee of the Council reported a year of high activity. Some 63 institutions involving 299 curricula were inspected and 28 institutions with 102 curricula received interim consideration. Also, during the year, several technical institutes were visited. This Committee proposed certain additional criteria for accrediting which were discussed and approved by the Council.

The Guidance Committee has continued its program, actively working with other engineering groups on the guidance problem.

The Student Development Committee reported that considerable progress has been made in this work area.

The Training Committee has spent much time on the projects now in operation in Cincinnati and Detroit and in formulating programs for future work.

The Recognition Committee and the Ethics Committee have continued their programs of action and are working in co-operation with other engineering groups.

The ECPD-EJC joint committee presented a brief interim report.

The paper and discussion parts of the Annual Meeting program were well attended and the discussions were spirited.

ENGINEERS JOINT COUNCIL

The Engineers Joint Council is continuing to expand and now consists of 9 constituent societies, 2 associate societies, and 2 affiliate societies with additional applications pending. Development of EJC as a unity organization is progressing slowly with little support for the AIEE desire for individual membership.

The EJC National Assembly initiated in 1955 was successfully repeated in 1956 and may be considered an annual affair with forums on important subjects of national interest.

The General Nuclear Congress held in Cleveland, Ohio, in 1955 was exceptionally well received. A total of 252 papers were presented at the 50 sessions held. More than 2,700 engineers registered. It is planned to hold the second Congress early in 1957.

REPRESENTATIVES

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

During the 1955 annual meeting of the American Association for the Advancement of Science (AAAS) at Atlanta, Ga., Section M presented six sessions in which 19 papers were delivered. The attendance varied from a maximum of 68 to a minimum of 26. There were also two luncheon meetings with an attendance of 36 and 32, respectively.

On December 30, 1955, the Council of the AAAS considered the problem of improving attendance at Council meetings. It was agreed to consider the possibility of obtaining funds to pay the travel expenses of Council members. Each constituent society will be asked to express an opinion on this point.

AAAS is expanding rather rapidly the number of organizations associated with AAAS on either an "associate" or "affiliate" basis. As a result, the membership of AAAS Council is expanding and the diversity of interest is very great. Also, there is a vast difference, in the size of the organizations represented on Council. Under these circumstances, the real effectiveness of AAAS Council is open to some question.

ATOMIC ENERGY COMMISSION ADVISORY COMMITTEE ON INDUSTRY INFORMATION

This Committee has continued in its activities of reporting to the Atomic Energy Commission information which would be considered valuable to industry if made available, and in recommending procedures relative thereto.

GENERAL ELECTRIC EDUCATIONAL AND CHARITABLE FUND FELLOWSHIP COMMITTEE

A committee of 10 representatives of engineering and scientific societies and educational institutions met on March 26th to consider 442 applications for graduate fellowships, following advance review of qualifications in digest form. Thirty-four Fellowships were awarded, of which 28 are offered in physical sciences, engineering, and industrial management; and 6 in arts and sciences, law and business.

It is noteworthy that alternates are selected so that all fellowships are awarded, as compared with National Science Foundation fellowships offered in similar fields of work. Electrical engineering recipients include: R. B. Ash, Columbia University; W. B. Bridges, University of California; L. F. Eastman, Cornell University; I. M. Jacobs, Massachusetts Institute of Technology; and R. E. Levin, Stanford University.

Closing date for applications for 1957–1958 awards has been advanced to January 15, 1957, to allow more time for processing and selection.

STANDARDS COUNCIL OF THE AMERICAN STANDARDS ASSOCIATION

There has been no meeting of Council during this period, but one was held June 1, 1956; by correspondence and letter ballot, however, approval has been granted to approximately 250 submittals, bringing the total of "American Standards" to 1,600; and shortly there will be distributed by the American Standards Association, without charge, a new price list, and also a new edition of "The 400 American Standards in the Electrical Field," describing the standards, together with descriptive paragraphs and information on all IEC publications and activities.

The Electrical Standard Board, with which AIEE is most concerned, has approved by letter ballot a revision bringing its Constitution in line with Article *B4* of ASA Bylaws, together with a procedure to speed up approval of personnel and scopes of Sectional Committees.

In the past, conflict of definitions for the same items in submittals by separate groups has caused serious delay in processing the submittals involved. To forestall such occurrences, a special committee has developed a suggested procedure, patterned closely upon the AIEE practice employed since October 1947. Now out for letter ballot, if, as seems probable, it is approved it will not only be sent to Sponsors, Chairmen, and Secretaries of all ASA projects in the electrical field, but also since it is a matter of grave concern to all other Boards, it will be submitted to Council for consideration and, at least in principle, adoption as ASA standard practice.

UNITED STATES NATIONAL COMMITTEE, INTERNATIONAL ELECTROTECHNICAL COMMISSION

A most successful meeting of the International Electrotechnical Commission (IEC) was held in London from June 28 to July 9, 1955. More than 500 overseas delegates attended in addition to more than 110 delegates from the United Kingdom. Twenty-five of the 30 member countries were represented. The United States National Committee was represented by 30 delegates.

Nineteen technical trips were arranged to—the National Physical Laboratory, the television studios, and a large number of manufacturing plants in both heavy and light industries. In addition, 13 social events were also arranged for the ladies. These included a number of teas and receptions as well as visits to points of scenic and historic interest.

Two meetings of the Committee of Action and one of the Council of the IEC were held. Dr. Percy Dunsheath, retired, director of research of Henley Cables and, for many years, treasurer of the IEC, was elected president and Dr. Arnold Roth of Switzerland, was elected treasurer to succeed Dr. Dunsheath.

Many administrative decisions affecting relations among the various technical committees and the general operation of the IEC were taken by the Committee of Action which is responsible for the operation of the IEC. Among these was authorization of the two new technical committees, one on protective relays and the other on high-voltage testing techniques. This latter will include work on high-voltage testing and measurements of high-voltage testing and measurements of high-voltage and impulse voltages and currents formerly handled by technical committee 36 on insulators and bushings and 28 on insulation co-ordination.

The invitation of the German National Committee to hold the next annual meeting of the IEC in Munich, Germany, June 27 through July 6, 1956, was accepted and preliminary invitation of the Spanish Committee to hold the 1957 general meeting in Madrid, Spain, was tentatively accepted

A summary of the technical accomplishments is given in the following paragraphs.

The difference in safety requirements for electric equipment in different countries which are mandatory is recognized as an obstacle to international trade, it was reported. To help bring about greater uniformity in safety codes and regulations, a working group was organized with H. A. R. Binney, director of the British Standards Institution, as chairman; and R. C. Sogge, U. S. representative. This group will act in line with the view expressed by the Committee of Action that the ". . . preparation of appropriate IEC Recommendations covering the fundamental aspects of safety and like matters is a matter of urgency." Technical Committees will be asked to incorporate

safety provisions in their recommendations.

The Swedish National Committee accepted the secretariat of the new technical committee on High-Voltage Testing Techniques (No. 42). M. H. Puppikofer, Switzerland, is chairman.

Because of the increasing work in electronics and telecommunications, an Electronics and Telecommunications Advisory Committee was set up to advise the Committee of Action on work in these fields. Its responsibility will be to help co-ordinate the work of IEC technical committees on telecommunications and electronics, and to serve as liaison with other international bodies in these fields as well as with technical committees other than those strictly concerned with electronics and telecommunications. The committee will be made up of the chairmen of the interested IEC technical committees. Dr. Dunsheath, president of IEC, will be chairman.

A proposal on standardization of ferromagnetically soft materials, presented by the Netherlands, has been circulated to the National Committees.

Technical Committee No. 2, Rotating Machinery, has set up a new subcommittee to investigate the question of impulse voltage testing of rotating machinery. The United Kingdom holds the secretariat.

The first list of graphical symbols completed by Technical Committee No. 3 has been approved and will be published as an IEC recommendation. Draft lists of symbols for resistors, impedances, inductors, windings, and capacitors, and for machines and transformers will soon be circulated to the National Committees for approval under the Six Months' Rule. A document on classification and definition of circuit diagrams also will be circulated.

A number of draft specifications prepared by Technical Committee No. 7 on aluminum are to be circulated for approval under the Six Months' Rule. These include a specification for commercial hard-drawn aluminum electric conductor wire; a specification for aluminum alloy electric conductor wire of the Al si Mg type; and a specification for commercial aluminum busbars.

The urgency of standardizing measurement of intermodulation distortion (acoustical) and acoustic measurements of receivers will be called to the attention of technical committees as the result of this meeting. Revised recommendations for measurements on television receivers will be circulated to the National Committees for approval under the Six Months' Rule. The revision was prepared by Technical Committee 12, Radio-Communication.

Three draft specifications on terminal markings—for power transformers, for instrument transformers, and for identification of conductors—were completed by Technical Committee 16 and will be circulated to the National Committees for approval.

Drafts on unit testing of circuit breakers and on rules for operating conditions have also been completed by Technical Committee 17 on Switchgear and Control gear and will be circulated soon for approval by the National Committees.

A new IEC Recommendation on plugs and socket outlets for domestic use as well as for general use has been approved and will be published soon. In addition, Technical Committee 23, Electrical Accessories, now has in preparation a draft specification for Edison screw lampholders.

Revisions and new definitions are being considered for IEC Publication 71 on co-ordination of insulation. These, and a number of other points, will soon be voted on as a supplement to this publication. The points under consideration include addition of a new column of values for power-frequency test voltages up to 72.5 kv; change of the rule for contamination and humidity of external insulators; test voltages for 420 kv; and addition of minimum clearance distances in air.

Technical Committee 33, Capacitors for Power Systems, has drafted specifications for shunt capacitors for use under tropical conditions. This is now ready for circulation to the National Committees under the Six Months' Rule.

Recommendations for glass insulators for overhead lines for 1,000 volts and above have been approved by the National Committees and are being published as an IEC Recommendation.

A draft specification for insulated bushings has also been completed by Technical Committee No. 36, High-Voltage Tests—Insulators, and is to be circulated to the National Committees.

A number of documents on electronic tubes and valves are to be circulated to the National Committees following completion by Technical Committee 39. They are on dimensions for subminiature outline gauges; a new type of base; and a new outline used with small button noval 9-pin base.

Technical Committee 40 on Electronic Components has been unusually active during the past year. As a result of its work two IEC Recommendations have been completed and are being published. One is a specification for fixed paper capacitors for direct current, including a color code; and the other is recommendations for rated characteristic impedances and diameters of radio-frequency cables. Three other documents have been completed and are to be circulated under the Six Months' Rule. These are a specification for receiver type metallized mica capacitors, including a color code; a specification for fixed carbon composition resistors; and general requirements and measuring methods for radio-frequency cables. A new subcommittee to deal with general testing methods was set up with the United Kingdom holding the secretariat.

The first Charles le Maistre Memorial Lecture was given at the Royal Institution, London, England, on the occasion of the 1955 meeting of the International Electrotechnical Commission.

UNITED STATES NATIONAL COMMITTEE WORLD POWER CONFERENCE

The United States National Committee, with the assistance of a Reviewing Committee and the authors approved and submitted 24 papers for presentation at the Fifth World Power Conference which will be held in Vienna, Austria June 17–23, 1956. The chairman of the United States National Committee was appointed the official delegate to the Fifth World Power Conference.

Future meetings of the World Power Conference (WPC) have been approved for Yugoslavia in 1957, Canada in 1958, Switzerland in 1960, and a plenary session in Australia in 1962.

The World Power Conference will hold a Sectional Meeting in Montreal, Que., Canada, September 7–11, 1958. This meeting will be co-ordinated with a meeting of the International Commission on Large Dams which will hold its Sixth Congress in New York, N.Y., September 15–20, 1958.

The United States National Committee and Executive Board met in New York, N. Y., January 20, 1956. The treasurer submitted the financial report for the year ending December 31, 1955, and it was approved. The budget for 1956 was submitted and it indicated that it would exceed the income, thereby reducing the financial reserve. It was recommended that the Executive Board appoint a committee to study the financial status of the United States National Committee, WPC with a view of obtaining additional contributions or funds to place the Committee on a sound financial basis. Upon recommendations of the Committee, the Executive Board appointed a task group to consider deleting from Article II, Section 2 of the Bylaws, the words "except to serve on the Executive Board" and also to make the necessary revisions pertaining thereto in Article VIII, Section 4, of the Bylaws.

APPRECIATION

The Board of Directors wishes to record its appreciation of the continuing excellent work of the general committees, the technical divisions and committees, and the District, Section, and Branch officers and committees. It also expresses its thanks to the membership for the widespread interest and participation in the activities.

Respectfully submitted for the Board of Directors.

N. S. Hibshman,
Secretary

HASKINS & SELLS
CERTIFIED PUBLIC ACCOUNTANTS

67 BROAD STREET
NEW YORK 4

ACCOUNTANTS' CERTIFICATE

American Institute of Electrical Engineers:

We have examined the balance sheet of American Institute of Electrical Engineers, and schedule of securities owned, as of April 30, 1956, and the related statements of income and operating fund reserve and of restricted fund reserves for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheet, schedule of securities owned, and statements of income and operating fund reserve and of restricted fund reserves present fairly the financial position of the Institute at April 30, 1956, and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

(*Signed*) HASKINS & SELLS

New York,
June 1, 1956.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Exhibit A — **Balance Sheet, April 30, 1956**

ASSETS

Property Fund Assets:		
Founder's interest (one-fourth) in capital assets of United Engineering Trustees, Inc.:		
Land, buildings, and equipment (less funded depreciation and renewal reserve)	$235,723.44	
Funded depreciation and renewal reserve	262,725.04	
Total	$498,448.48	
Other (at nominal value):		
Library	1.00	
Works of art, etc.	15.00	
Total property fund assets		$ 498,464.48
Restricted Fund Assets:		
Securities—at cost (quoted market value $1,129,236.45)—Schedule 1	$755,968.89	
Cash	38,038.29	
Accrued interest purchased	238.78	
Total restricted fund assets		794,245.96
Operating Fund Assets:		
Cash	$235,879.40	
Accounts receivable:		
Members—for dues	53,842.22	
Advertisers	9,144.66	
Technical Conference loans	550.00	
Subscribers to *Transactions*, etc.	32,613.42	
Inventories—at cost or less:		
Transactions	15,718.00	
Text and cover paper	10,514.93	
Badges	5,279.47	
Production charges for May issue of *Electrical Engineering*	27,690.91	
Other prepaid expenses	4,785.89	
Office furniture and fixtures (less reserve for depreciation, $54,251.65)	31,825.15	
Total operating fund assets		427,844.05
Total		$1,720,554.49

LIABILITIES

Property Fund Reserve:		
Founder's interest (one fourth) in capital assets of United Engineering Trustees, Inc.:		
Land, buildings, and equipment (less funded depreciation and renewal reserve)	$235,723.44	
Funded depreciation and renewal reserve (marketable securities and cash held by United Engineering Trustees, Inc.)	262,725.04	
Total (unchanged during the year)	$498,448.48	
Other	16.00	
Total property fund reserve		$ 498,464.48
Restricted Fund Reserves (Exhibit C):		
Reserve capital fund	$705,037.54	
Life membership fund	5,434.77	
Member-for-Life fund	23,431.06	
International Electrical Congress of St. Louis Library fund	6,608.09	
Edison Endowment fund	8,146.04	
Edison Medal fund	9,998.17	
Lamme Medal fund	9,515.78	
Mailloux fund	1,038.85	
Volta Memorial fund	15,035.66	
Retired employees' insurance fund	10,000.00	
Total restricted fund reserves		794,245.96
Operating Fund Reserve, Liabilities, Etc.:		
Accounts payable	$ 65,113.92	
Accrued expenses	11,323.69	
Deferred income, etc.:		
Dues (including $53,842.22 uncollected)	81,386.52	
Subscriptions to publications, etc. (including $24,505.20 uncollected)	53,842.10	
Other	1,960.19	
Operating fund reserve (Exhibit B)	214,217.63	
Total operating fund reserve, liabilities, etc.		427,844.05
Total		$1,720,554.49

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Exhibit B — **Statement of Income and Operating Fund Reserve for the Year Ended April 30, 1956**

Income:		
Dues:		
Members	$778,334.92	
Students	33,697.50	
Fees:		
Entrance	18,303.34	
Transfer	3,620.00	$ 833,955.76
Publications sales:		
Advertising	$407,264.96	
Electrical Engineering subscriptions, etc.	38,889.02	
Transactions volumes	26,947.92	
Bimonthlies subscriptions, etc.	17,117.63	
Preprints, special and technical publications, etc.	63,928.91	554,148.44
Other income:		
Meetings registration fees	$ 37,989.03	
Technical conference—net	6,436.69	
Interest and dividends on investments of Reserve Capital Fund	30,629.10	
Standards sales (including binders)	9,767.06	
Members emblems	2,606.99	
Miscellaneous	279.30	87,708.17
Total income		$1,475,812.37
Expenses:		
Institute Activities:		
Committees:		
Constitution and Bylaws	$ 2,065.42	
Finance	1,900.00	
Headquarters	343.01	
Membership	29,233.80	
Planning and Co-ordination	23,244.61	
Public Relations	21,138.03	
Standards	24,619.65	
Technical	27,450.22	
Other	137.36	$ 130,132.10
Travel:		
Board of Directors	$ 16,776.67	
Geographic Districts Executive Committee	16,451.43	
Section delegates to Summer General Meeting	15,678.17	
Geographic Districts—Student Conferences	8,065.63	
Vice-Presidents	2,516.52	
Incoming Vice-President District Secretaries to Summer General Meeting	2,844.09	
Nominating Committee	1,957.59	
Branch counselors to Summer General Meeting	1,650.57	
President	822.28	
Institute representatives	197.90	66,960.85
Forward		$ 197,092.95
Total Income (Forward)		$1,475,812.37
Expenses (Continued):		
Institute Activities—(Forward)		$ 197,092.95
Joint Activities:		
United Engineering Trustees:		
Building assessments	$ 26,370.79	
Library assessments	19,708.50	
Library pension	4,902.85	
Special Task Committee	8,000.00	
Engineers' Joint Council	4,160.39	
Engineers' Council for Professional Development	3,187.50	
American Standards Association	1,500.00	
National Council of State Boards of Engineering Examiners	500.00	
Conference of representatives from the Engineering Societies of Western Europe and the U. S. A.	414.37	
U. S. National Committee—International Commission on Illumination	300.00	
Engineers' Foundation—Welding Research	250.00	
National Fire Protection Association	100.00	69,394.40
Prizes and awards:		
Institute prizes	$ 653.13	
Geographical Districts—Branch Paper Prizes	501.66	
Section prizes	2,402.96	
Branch prizes	820.02	
Branch travel	5,384.66	9,762.43
Institute Sections		106,814.28
Institute Branches		21,021.04
Institute Meetings		51,528.93
Total Institute Activities Expense		$ 455,614.03
Publications:		
Electrical Engineering:		
Text	$204,778.45	
Advertising	211,090.97	
Transactions volumes	33,755.50	
Bimonthlies	115,530.43	
Year Book	5,815.69	
Preprints, special and technical publications, etc.	80,062.02	651,033.06
General and Administrative:		
Salaries	$122,780.33	
Postage	8,560.55	
Stationery and supplies	17,047.84	
Retirement system—A.I.E.E.—normal contribution, etc.	13,972.61	
Social Security taxes	5,023.19	
Depreciation of furniture and fixtures	5,075.85	
Legal fees	250.00	
Miscellaneous	15,744.13	188,454.50
Total expenses		$1,295,101.59
Excess of Income Over Expenses for the Year		$ 180,710.78
Operating Fund Reserve—May 1, 1955		33,506.85
Operating Fund Reserve—April 30, 1956		$ 214,217.63

Exhibit C **Statement of Restricted Fund Reserves for the Year Ended April 30, 1956**

	Total	Reserve Capital Fund	Life Membership Fund	Member-for-Life Fund	International Electrical Congress of St. Louis Library Fund	Edison Medal Fund	Edison Endowment Fund*	Lamme Medal Fund	Mailloux Fund	Volta Memorial Fund	Retired Employees' Insurance Fund
Balance, May 1, 1955	$748,348.25	$668,341.35	$5,976.97	$20,698.90	$6,619.04	$ 9,878.99		$9,427.23	$1,036.67	$16,369.10	$10,000.00
Additions:											
Received from New York Trust Company	*8,049.79						$8,049.79				
Contribution	85.00			85.00							
Income from investments	1,897.57	**	126.05	181.25	126.05	810.00	96.25	345.00		212.97	
Interest on bank balances	40.66		12.28						28.38		
Dues paid by Members-for-Life	4,870.68			4,870.68							
Profit (loss) on sale of securities	36,633.38	36,696.19								(62.81)	
Total	$799,925.33	$705,037.54	$6,115.30	$25,835.83	$6,745.09	$10,688.99	$8,146.04	$9,772.23	$1,065.05	$16,519.26	$10,000.00
Deductions:											
Authorized withdrawal from life membership fund	$ 680.53		$ 680.53								
Purchase of medals, cost of engraving, etc.	947.27					$ 690.82		$ 256.45			
Library purchases	163.20				$ 137.00				$ 26.20		
Traveling expenses—District Branch prize winners	2,384.80			$ 2,384.80							
Scholarship awards	1,475.00									$ 1,475.00	
Cable charges, etc.	28.57			19.97						8.60	
Total deductions	$ 5,679.37		$ 680.53	$ 2,404.77	$ 137.00	$ 690.82		$ 256.45	$ 26.20	$ 1,483.60	
Balance, April 30, 1956 (Exhibit A)	$794,245.96	$705,037.54	$5,434.77	$23,431.06	$6,608.09	$ 9,998.17	$8,146.04	$9,515.78	$1,038.85	$15,035.66	$10,000.00

* Under final court order dated June 28, 1955, the Institute received cash and securities in the total amount of $8,049.79 of which $7,985.92 represented principal and the remainder, $63.87, represented income. The Institute represents and covenants that it will hold the principal as an endowment fund and apply the income therefrom for the uses and purposes and objects and under the terms and conditions as provided for in the Trust Indenture, dated February 11, 1904 as amended March 26, 1908, creating "The Edison Medal."

At April 30, 1956, the fund balance represented principal, $7,985.92, and income, $160.12.

** Income of $30,629.10 from Reserve Capital Fund investments is credited to operating fund (see Exhibit B).

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Schedule 1 — **Restricted Funds—Securities Owned, April 30, 1956**

Name of Issuer and Title of Issue	Principal Amount	Book Value
Reserve Capital Fund:		
Bonds:		
Public utility bonds:		
American Telephone & Telegraph Company 2¾% debentures:		
Due 1971	$20,000.00	$ 19,650.00
Due 1975	10,000.00	10,062.50
Philadelphia Electric Company first refunding 2¾%, due 1967	20,000.00	20,412.50
Total public utility bonds		$ 50,125.00
Industrial bonds:		
Shell Union Oil Company 2½% debentures, due 1971	$20,000.00	$ 19,800.00
Socony Vacuum Oil Company, Inc. 2½%, due June 1, 1976	30,000.00	27,730.00
Standard Oil Company of New Jersey 2¾% debentures, due 1971	20,000.00	19,675.00
Total industrial bonds		$ 67,205.00
Dominion of Canada, externals 3%, due 1963	$10,000.00	$ 10,050.00
United States Government bonds:		
Treasury bonds:		
2¼%, due September 15, 1961	30,000.00	$ 29,793.76
2½%, due August 15, 1963	40,000.00	38,750.00
2½%, due December 15, 1972/67	35,000.00	34,814.06
Treasury savings bonds:		
Series G 2½%, due November 1, 1956	17,000.00	17,000.00
Series G 2½%, due May 1, 1957	20,000.00	20,000.00
Series G 2½%, due October 1, 1957	30,000.00	30,000.00
Series G 2½%, due May 1, 1961	30,000.00	30,000.00
Series G 2½%, due July 1, 1961	15,000.00	15,000.00
Total United States Government bonds		$215,357.82
Total bonds		$342,737.82
Capital stocks:		
Preferred stocks:	Number of shares	
Atchison, Topeka & Santa Fe Railway Company	400	$ 19,174.71
General Motors Corporation $5	200	25,820.00
Ohio Edison Company 4.40%	200	21,279.25
Scovill Manufacturing Company 3.65% cumulative	100	10,111.25
United States Steel Corporation 7% cumulative	100	14,885.00
Total preferred stocks		$ 91,270.21
Common stocks:		
American Gas & Electric Company	612	$ 10,501.07
American Telephone & Telegraph Company	250	44,201.21
Caterpillar Tractor Company	600	13,283.36
Christiana Securities Company	5	34,625.00
Eastman Kodak Company	319	7,634.71
General Electric Company	650	9,924.77
General Motors Corporation	600	4,235.53
International Paper Company	210	8,357.80
Louisville & Nashville Railroad Company	100	6,278.13
Monsanto Chemical Company	204	6,423.73
Pacific Gas and Electric Company	300	12,652.32
Public Service Company of Indiana	300	8,547.39
Public Service Electric & Gas Company $1.40 dividend preference common stock	500	14,462.43
Sears, Roebuck and Co.	909	4,511.23
Socony-Mobil Oil Co.	400	8,146.18
Standard Oil Company of Indiana	500	22,676.06
Standard Oil Company of New Jersey	1,206	9,910.35
Texas Utilities Corporation	600	9,780.29
Union Carbide & Carbon Corporation	300	7,277.42
Westinghouse Electric Corporation	400	18,409.80
Total common stocks		$261,838.78
Total capital stocks		$353,108.99
Total (Forward)		$695,846.81

Name of Issuer and Title of Issue	Principal Amount or Number of Shares	Book Value
Total (Forward)		$695,846.81
Life Membership Fund:		
American Telephone & Telegraph Company 2¾% debentures, due 1975	$ 5,000.00	$ 5,031.25
Member-for-Life Fund:		
American Telephone & Telegraph Company 2¾% debentures, due 1971	5,000.00	$ 4,775.00
United States Treasury bonds 2½%, due December 15, 1972/67	5,000.00	4,973.44
Total		$ 9,748.44
International Electrical Congress of St. Louis Library Fund:		
American Telephone & Telegraph Company 2¾% debentures, due 1975	$ 5,000.00	$ 5,031.25
Edison Endowment Fund:		
United States Treasury bonds 2½%, due June 15, 1967	7,700.00	$ 7,827.45
Edison Medal Fund:		
General Electric Company common stock	450	$ 9,131.25
Lamme Medal Fund:		
E. I. du Pont de Nemours & Company $4.50 cumulative preferred stock	50	$ 5,952.00
General Motors Corporation $5 preferred stock	24	2,980.44
Total		$ 8,932.44
Volta Memorial Fund:		
United States Treasury bonds 2¼%, due December 15, 1962/59	$14,000.00	$ 14,420.00
Total		$755,968.89

IN EDUCATIONAL CIRCLES

ACTIVITIES AND INTERESTS

18 Schools Represented at District 5 Student Paper Contest

STUDENT REPRESENTATIVES of 18 schools in the Midwest presented papers at the District 5 conference and student paper competition which was held May 11–12 at Purdue University, Lafayette, Ind.

The winner of the undergraduate competition was Roger Dolak, Iowa State College, for his paper, "Effect of the Inversion Layer upon Radar." The graduate paper winner was Donald Schulz, University of Wisconsin, who presented a paper entitled "Transistor Differential Amplifiers."

Other winners in the undergraduate competition were James Massey, University of Notre Dame, second place for his paper "The Magnetic Monopole," and V. S. Levadi, Illinois Institute of Technology, third place with a paper on the subject of "Remote Tuning via Transmission Lines."

Honorable mention awards were presented to E. K. Ranke, University of Detroit, for "The Fundamental Physics of Nonlinear Dielectrics"; and F. R. Woldt, University of Wisconsin, for his paper, "Ground-to-Air Missile Guidance Systems."

H. Y. Juliusburger, "Application of Carbon Pile Voltage Regulators to Small Separately Excited D-C Generators," Northwestern University, was second place winner in the graduate competition, and Richard Bucich, Illinois Institute of Technology, was third with "Fourier Integral Analysis by Superposition."

Undergraduate papers also were presented by Ron Butler, "The Need for Higher Transmission Voltages," University of Iowa; G. S. Hauffe, "Noise and Its Measurement," Marquette University; Rodrigo Junqueira, "Electrical Energy in Brazil," Michigan College of Mining and Technology; R. W. Powell, "Man-Made Minds," Michigan State University; Norman Johnson, "Noise Sources," University of Michigan; G. D. Morant, "Mechanical Load Failure Detector for Electric Motors," Milwaukee School of Engineering; J. F. Lindfors, "The S Generator Metadyne and Its Applications," University of Minnesota; J. L. Vonderheide, "A Wireless Microphone," North Dakota State; M. M. Orseth, "The Solar Battery," University of North Dakota; P. J. Leahy, "Robot—Electronics," Northwestern University; E. H. Ogle, "The Electrical Engineer in Nuclear Power," Purdue University; Charles Tolson, "Human Relations in Industry," Rose Polytechnic Institute; and Joseph Vogel, "Recent Developments in Radio Astronomy," South Dakota State.

The speaker for the May 11 luncheon was P. F. Chenea, assistant dean of Engineering, and head of the School of Engineering Sciences, Purdue University, and the speaker for the May 11 dinner was J. S. Johnson, head, School of Electrical Engineering, Purdue University.

R. J. Ungrodt, assistant dean of Engineering, Milwaukee School of Engineering, who is chairman of the 5th District Committee on Student Activities, presided at the awards presentation meeting and the business meetings of the group on both days of the conference.

New Program Announced by University of Maryland

A four-year curriculum in fire protection leading to a degree of bachelor of science will be offered at the University of Maryland at College Park, it was announced by Dean S. S. Steinberg of the College of Engineering.

The program, which will begin in September 1956, has been planned for those students who desire to make their career in fire protection and prevention and devote their lives to the public interest in this field. It has been designed to emphasize the scientific and technical nature of fire prevention, its humanitarian aspects, and the development of the individual.

The first two years of the curriculum will be practically identical with the freshman and sophomore years in the College of Engineering; also, the entrance requirements are the same as for that college.

In addition to the basic and technical subjects required throughout the four years, there have been included certain cultural courses such as American and English literature, history of American civilization, public speaking, sociology, and government.

For the senior year, provision has been made for nine credit hours of elective courses which the student may select from the fields of industrial education, sociology, psychology, business administration, public relations, philosophy, and art.

Fire protection courses will be taught in

Above, left: The undergraduate paper competition winners and judges at District 5 conference, Purdue University, May 11–12, were: (*left to right*) M. L. Miller, General Electric Company, judge; E. E. Sterner, Western Electric Company, judge; H. H. Armstrong, Detroit Edison Company, judge; James Massey, University of Notre Dame, second place winner; C. M. Summers, General Electric Company, vice-president of District 5; F. R. Woldt, University of Wisconsin, honorable mention; E. K. Ranke, University of Detroit, honorable mention; and Roger Dolak, Iowa State College, first place winner. Above, right: The winners of the graduate student paper competition, (*left to right*) Richard Bucich, Illinois Institute of Technology, third place; H. Y. Juliusburger, Northwestern University, second place; and Donald Schulz, University of Wisconsin, first place, are congratulated by Mr. Summers. R. J. Ungrodt, assistant dean of Engineering, Milwaukee School of Engineering, and chairman of District 5 Student Activities Committee, presided at the awards presentation.

connection with the facilities of the Fire Service Extension Department. The theoretical and laboratory work will be supplemented by field problems and trips to industrial and other fire protection installations.

Inquiries should be sent to the Director of Admissions, University of Maryland, College Park, Md.

Fenn College Coed Wins Tau Beta Pi Badge

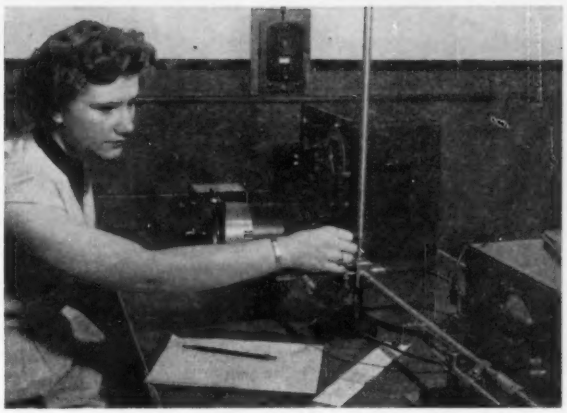
The secretary of the Fenn College chapter of AIEE, Margaret R. Stevens, is the first Cleveland, Ohio, coed to win the Women's Badge of the honorary engineering fraternity, Tau Beta Pi.

Miss Stevens, an electrical engineering major, is the 10th in Ohio and 208th in the nation to win Tau Beta Pi recognition since the award was set up 20 years ago.

Earned in her junior year at Fenn, her honor holds greater distinction. To qualify for the Badge, a woman student must meet the same requirements that men do for membership. This means rank in the upper eighth of the junior class, display exemplary character, and earn the majority vote of active chapter members. The Fenn chapter also stipulates a minimum 3.0 point-hour ratio—equivalent to straight B's—which further narrows down eligibility.

In 1953, Miss Stevens became the first coed to win a freshman scholarship to the Fenn School of Engineering. At the college, she has been active in the student chapters of the Institute of Radio Engineers, and AIEE.

Earlier this year, Miss Stevens was awarded a student membership in the Cleveland District Council of the American Society for Testing Materials. She has spent four co-operative work quarters with Tocco Division of Ohio Crankshaft, and hopes to work in the induction heating field after graduation.



MARGARET R. STEVENS, first Fenn College coed to win the Women's Badge of Tau Beta Pi, works with an admittance meter in the college electrical engineering laboratory. She is measuring impedance at high frequency.

Courtesy Hastings-Willinger and Associates

Alabama Section Visits API Branch for Joint Meeting

As a climax to a year of close co-operation between the two groups, some 33 members of the Alabama Section and Montgomery Subsection, headed by their respective chairmen, R. E. Williams and W. C. Wingard, visited the Alabama Polytechnic Institute (API) Student Branch at its regular meeting held on May 7. The group of visitors arrived in Auburn, Ala., at 4 p.m., then made an inspection tour of the Electrical Engineering Laboratories under the guidance of Prof. R. D. Spann, head of the department and the electrical engineering faculty. Regular laboratory periods were in progress giving both "old grads" and non-alumni a dynamic rather than a static picture of the present-day labs. Following the inspection, the visitors dined with the Student Branch prior to the meeting at 7 p.m. Following a brief business session under Chairman Johnson Overcash of the Student Branch, and brief remarks by Chairmen Williams and Wingard, the group listened to the speaker of the evening E. C. Gaston, vice-president of Southern Services, on the subject "The Civilized Atom." This excellent talk on the problem of reactor design for peaceful use was followed by an equally informative question and answer period. All present agreed that the meeting drew the two groups together to a better understanding of the AIEE.

Highway Engineering Conference Held at LSU

The uses of the electronic computer for automation of highway engineering computations were discussed in a recent conference held on the Louisiana State University (LSU) Campus, Baton Rouge, La., sponsored by the LSU department of civil engineering and College of Commerce, and the Louisiana Department of Highways. The meeting, attended by engineers, professors, and accountants from 14 states in the East, Midwest, West, and South, covered methods of converting rod readings to actual elevations, computing grades over vertical curves, computing elevations of superelevated and widened curves, and computing areas and volumes from field notes.

Dr. F. J. Germano, head of civil engineering department, LSU, stated that the use of electronic computers is an important step in the conservation of manpower for engineering purposes. He continued to say that the Louisiana Department of Highways has been the first to show that volumes of earth for highway construction can be obtained from field notes seven times as fast by electronic computers as by the conventional, tedious methods.

The accounting section of the Louisiana Department of Highways, a leading state organization in regard to cost and budgetary accounting, presented problems dealing with payroll computations and equipment costs. During this discussion, N. P. Himbert, Louisiana Highway Auditor, pointed out that his accounting section had saved approximately $20,000 per year on accounting alone since conversion to the use of electronic computers. Mr. Himbert also pointed out that the department can handle the contemplated expansion of work due to

SOME OF THOSE ATTENDING the joint meeting of the Alabama Section and the Alabama Polytechnic Institute (API) Student Branch, held May 7, were: *(left to right)* R. C. Williams, chairman, Alabama Section; W. C. Wingard, chairman, Montgomery Subsection; Johnson Overcash, chairman, API Student Branch; E. C. Gaston, vice-president, Southern Services, guest speaker; Joseph Pollard, secretary, API Student Branch; and Prof. R. D. Spann, head of electrical engineering department, API.

the proposed federal highway program without an appreciable increase in personnel.

The meeting was summarized by S. E. Ridge of the U. S. Bureau of Public Roads, Washington, D. C., who stressed the importance of development and use of electronic computations in order to conserve manpower and free professional engineers for more constructive work.

MSU Makes Plans for New College of Engineering

Michigan State University (MSU) officials recently announced plans for a new College of Engineering on the south campus. The project, which will be developed over the next five years at an approximate cost of $13 million, calls for the development of a site south of the Red Cedar River in an area of approximately 20 acres.

According to Dr. J. D. Ryder, dean of engineering, the College of Engineering has asked for initial development of this site with buildings having a total area of 650,000 square feet. This would provide facilities for a student body of 4,000 engineering students, plus research activities and an expanded graduate program.

The movement to the new site was made necessary because available land area surrounding the present engineering buildings, the major one of which was built in 1916, is not sufficient to provide buildings with enough floor space for the growing engineering enrollment.

Planning money for the first unit has been approved in the current session of the legislature. This unit will house the departments of mechanical engineering and applied mechanics. To be constructed at a cost of $4 million, the new building will provide housing of about 175,000 square feet for the two departments now most seriously limited by space and increased enrollment.

The second unit in the five year development will be the civil engineering and engineering drawing building. Included in this construction of 100,000 square feet will be a separately financed wing to house the research laboratory of the state highway department now occupying space in the basement of Olds Hall.

The last two buildings to be added to the development of the site, under the present plan, will house the electrical engineering department and research activities of the engineering college with approximately 150,000 square feet. Another unit will house the chemical and metallurgical engineering departments with about 100,000 square feet.

Lowell Institute To Observe Perkin Centennial

Lowell (Mass.) Technological Institute, participating in the international 1956 observance of the Perkin Centennial, will hold a three-day celebration at the beginning of the academic year from September 26 through 28.

During that period, a lecture and display of rare books will be featured and, at a special convocation, honorary degrees will be conferred upon men famous all over the world in the fields of science, industry, and public service. Dedication of one of the newest buildings on the Lowell campus will take place, and the program will culminate in an Open House on Friday, September 28, marking the first time since 1937 that such a public open-house invitation has been extended.

At the Open House, all buildings may be visited by the general public who will see in operation the millions of dollars worth of equipment used for instructional purposes. Innumerable chemical, engineering, and manufacturing exhibits will be displayed in the electronic, plastics, textile, paper, and leather departments of the Institute, many geared especially to the interests of young people.

Twofold purpose of the affair is to show to the public the tremendous growth and development of the Institute, particularly within the past decade, and at the same time to honor the late Sir William Henry Perkin, discoverer of the first synthetic dye—mauve—100 years ago at the age of 18, while experimenting in a makeshift laboratory in the basement of his London, England, home. Sir William himself was among visitors to the campus—then the Lowell Textile School—50 years ago.

Lincoln Laboratory Issues New Brochure

Massachusetts Institute of Technology (MIT) Lincoln Laboratory has issued a brochure describing current opportunities in the fields of physics, electrical engineering, mathematics, and psychology. Doctors and graduate engineers interested in the possibility of working on classified projects may secure a copy of the bulletin by writing: Research and Development, MIT Lincoln Laboratory, Box 24, Lexington, Mass.

Manhattan College Establishes Metropolitan Planning Institute

The establishment of The Manhattan College Institute of Metropolitan Planning and Redevelopment has been announced by Brother Augustine Philip, F.S.C., president of the College.

The purpose of the Institute is to assist corporations, citizens, and local governments in the metropolitan area with their planning and redevelopment problems.

Brother Philip stated that in establishing the Institute, Manhattan College wishes to reaffirm its deep interest in the economic, social, and cultural progress of the metropolitan area.

Brother Amandus Leo, dean of the school of engineering, was named chairman of the Institute. Its staff will be named shortly.

In the past, organizations have sought the help of individual faculty members. The Institute will be able to give more expeditious and expert service and will help solve larger and more complicated problems that will be presented.

The facilities of all of the schools, particularly engineering, will be available for the work of the Institute.

Illinois Tech Contest Winners

WINNERS OF A PAPERS CONTEST for electrical engineering students at Illinois Institute of Technology, Chicago, Ill., look over one of the winning entries. The contest was sponsored by the Chicago Section of the AIEE. Authors of the prize-winning papers are: *(seated, left to right)* Richard Bucich, first place graduate winner; V. S. Levadi, first place undergraduate winner; and Richard Purnell, second place undergraduate winner. Looking on are three officers of the student chapter of AIEE at Illinois Tech *(left to right)* Harry Onishi, Frederick Graham, and George Bartimes.

Power Companies Use UW A-C Network Calculator

More than two million kilowatts of electric power, the product of four big Wisconsin and upper Michigan electric power plants, were put through their paces recently in a one-room laboratory of the University of Wisconsin (UW).

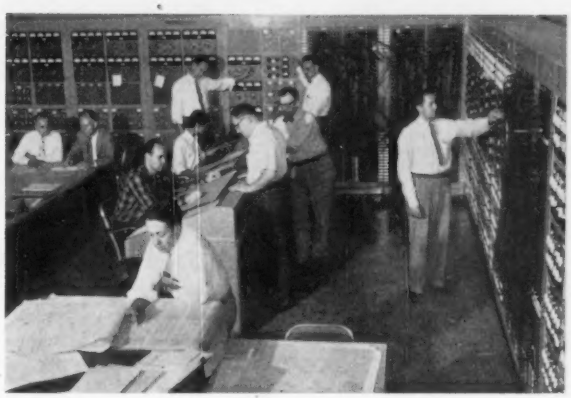
The generation and transmission of these kilowatts was studied on the A-C Network Calculator in an electrical engineering laboratory of the UW College of Engineering by engineers of the four power companies in an effort to determine how they can best serve more efficiently over a million users throughout the southern and eastern halves of Wisconsin—about two-thirds of the state.

Occupying one entire laboratory room, the complex calculator is composed of an intricate system of 17 miles of wire, 2,520 switches, and 120 meters, all of which behave like an actual a-c power system from the time electricity is generated until it reaches the home.

The complicated machine, given to the University by electric operating companies of the state who are members of the Wisconsin Utilities Association and by the Allis-Chalmers Manufacturing Company, is used by electrical engineering teachers and students to study problems in transmission and distribution of electricity.

Power companies use it to simulate problems within their own electrical systems. Engineers can reproduce in miniature the generating plants and lines under study. Through use of the calculator it is possible to study the effect of lightning or short circuits. It is also used to determine means of expanding electric system design by predicting the effect of proposed changes in electric load and the location of costly additions. The machine makes calculations in days that would require months if done by manual figuring.

The four Wisconsin companies using the network calculator recently were the Wisconsin Electric Power Company, Milwaukee; the Wisconsin Power and Light Company, Madison; the Wisconsin Public Service Corporation, Green Bay; and the Wisconsin-Michigan Power Company, Appleton.



ENGINEERS OF FOUR Wisconsin and upper Michigan power companies are shown with University of Wisconsin electrical engineers using the complex A-C Network Calculator in a University laboratory.

Courtesy University of Wisco

Science Teacher Workshop To Be Initiated at Columbia

A plan for contributing to a more adequate supply of well-trained high school teachers of science has been announced in the Newsletter issued jointly by Engineering Manpower Commission of Engineers Joint Council and the Scientific Manpower Commission. The plan will be initiated next fall at a year-long workshop at Teachers College, Columbia University. The workshop will be given with industry co-operation. It will be designed primarily for professors at teacher-education and liberal arts colleges that prepare science teachers. Its long-range goal is to increase the effective education and guidance of students in high school science courses and, thus, to increase interest and career work in the science oriented professions.

The workshop will get under way October 1, 1956, with 18 colleges represented, and will be financed jointly by industry and Teachers College of Columbia. It is hoped that four additional workshops can be set up at Teachers College through 1961 since the College believes that it will take at least five years for the program to make itself felt. In that time, workshop members will have introduced the results of their work in their own teacher-education colleges and have begun to train science teachers along the lines developed at the workshop. These teachers will then be able to do a more effective job of teaching science and cultivating gifted students for technological careers.

The workshop will be sponsored by the department of science of Teachers College. Policy will be made by an advisory board representing Teachers College and industry. The Columbia program is based on the realization that a revision is long overdue in teaching of the physical sciences where some high school courses have remained virtually static for the past five decades. Prof. F. L. Fitzpatrick, head of the Teachers College science department, states that science teaching should be brought up to date in content, improved in laboratory experiences, and generally made interesting in terms of today's realities in order to capture the natural interest of youngsters in science.

New Members of Tau Beta Pi

H. A. WHEELER (F '46) (*left*), consulting radio physicist and president of Wheeler Laboratories, Great Neck, N. Y., and L. M. Vallese (AM '48) (*center*), associate professor of electrical engineering and a member of the staff of the Microwave Research Institute of Brooklyn, are welcomed as new professional members of the Polytechnic Institute of Brooklyn campus chapter of the national honorary fraternity, Tau Beta Pi, by F. R. Zitzmann (*right*), Polytechnic Chapter president. Membership in this fraternity is one of the highest honors in an engineering college. The Polytechnic Chapter enrolled 20 members at its spring initiation.

OF CURRENT INTEREST

Tailor-Made Supermetal
Result of New Research Technique

SCIENTISTS of the Westinghouse Research Laboratories in Pittsburgh, Pa., unveiled a new super-alloy, one application of which is for high-temperature steam turbine blades. The alloy is the first practical result of a new research technique for "predesigning" metals of the future.

At a recent meeting in the Hotel Astor, Dr. Clarence Zener, acting director of Westinghouse research, and Dr. A. W. Cochardt, advisory metallurgist at the Westinghouse Research Laboratories, revealed that the new alloy—called Nivco—was deliberately predesigned to have high strength at temperatures as high as, 1,200 F, with the ability to resist mechanical vibration. This ability to kill mechanical vibration, called "damping," results from control of the magnetic arrangement of the atoms comprising the alloy, and was theoretically built in before the metal itself was actually prepared.

Dr. Zener said the research technique which produced Westinghouse's new superalloy is a direct result of a long-range materials development program. The technique permits the predesign of a needed set of properties into an alloy, thereby eliminating the time-consuming "cut-and-try" metallurgical methods usually employed. It promises to speed the discovery of other new alloys and insure that those developed will have the best possible properties within the alloying metals available. The research team which developed the new turbine blade material was headed by Dr. Cochardt.

Tremendous Forces Vibrate Blades

Whirling at 3,600 rpm inside the scorching interior of a steam turbine, turbine blades are subject to tremendous steady and varying forces which tend to make them vibrate. To reduce the amplitude of this vibration, the blades must be artificially damped, or the blade material itself must have self-induced damping so it will minimize vibration and keep the blade within safe limits. At the same time, the metal must retain strength and resistance to corrosion which is required of all turbine blade materials operating at higher temperatures.

Turbine blade materials used at present, such as 12-per-cent chrome steel, have excellent over-all properties up to about 1,050 F initial temperature. Above that temperature, however, chrome steel must be used at lower stress levels.

It has been recognized that improved turbine blade materials would be required by the larger higher-temperature turbogenerator units now being developed in recent years to realize higher thermal efficiencies for the large-scale generation of electricity.

New Material Stronger than Chrome Steel

The new alloy promises to be a material about five times stronger than chrome steel. At 1,200 degrees Fahrenheit, he said, Nivco has five times the strength of 12-per-cent chrome steel, and a damping nearly equal to chrome steel at 900 degrees.

The mechanical behavior of given alloys depend, at least in part, on individual magnetic properties. After several years of research, discovery was made of how to design needed mechanical behavior into certain alloys by control of their magnetic structure. This enables the predicting of behavior which will be obtained by combining certain metals in different proportions, and can be done without preparing and testing hundreds of thousands of potential combinations of two or more alloying metals.

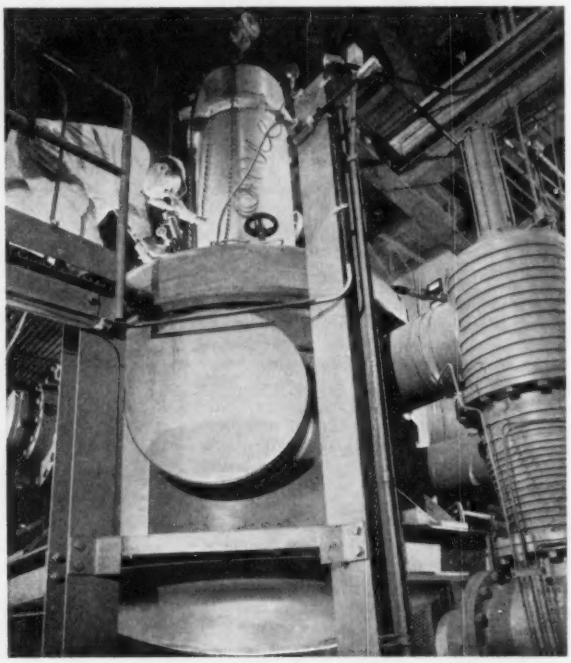
This technique, is a major forward step in metallurgical research, and this new alloy is the beginning of its application to practical situations.

Nivco snubs vibration of the turbine blading appreciably, simply because its magnetic structure dictates that it cannot vibrate. It is an ability which was consciously predesigned into the metal, and was foreseen well before a piece of the metal itself was a reality.

Nivco Result of Three-Stage Development

The new alloy was a three-stage research development. In the initial stage, an exhaustive study was made of the magneto-mechanical effects in metals including magnetostriction—the tendency for certain metals to change dimensions under the influence of a magnetic field. This research furnished the basic knowledge needed for predesigning the new alloy. In the second stage, theories were tested by preparing and analyzing some 50 different alloys, studying in detail their damping, corrosion resistance, hardness, tensile strength, and ductility. Finally, the strength and corrosion resistance of the highly damped alloys suggested by our theories and verified by their preparation were perfected, which resulted in an alloy that will prove to be an outstanding blading material for the steam turbine of tomorrow.

Although its exact composition was not disclosed, Dr. Cochardt said that Nivco was composed principally of cobalt and nickel



NIVCO, newly developed alloy for steam turbine blades is melted and cast into ingots inside this vacuum melting furnace, which is used in producing alloys of high purity, free of entrapped gases.

but that it included certain smaller amounts of five additional elements. The ultimate tensile strength of the metal is said to be about 100,000 pounds per square inch at 1,200 F, at which temperature the metal glows with a dull red heat. The alloy is prepared by melting in a vacuum furnace under an inert atmosphere of argon gas. After melting, it is treated and then is forged at 2,000 F.

New Generator Application Possible

Dr. Cochardt said that one possible application of the new alloy is in the superpressure turbogenerator now being built by the Westinghouse Steam Division in Philadelphia, Pa.

This new 325,000-kw turbogenerator is said to have the highest operating temperature and pressure, as well as the best plant heat rate of any existing or proposed unit for electric utility service.

The turbine which drives the electric generator will operate at a pressure above the critical pressure of water, meaning that it operates above the pressure at which water changes from a liquid into a gas without going through the vapor phase.

Steam engineers have stated that Nivco is a "natural" for this application, according to Dr. Cochardt, and that it will help make possible a major forward step in steam turbine design. Although it is expected that this new material will provide a solution of the problem of suitable turbine blade material for several years to come, the search for even better ones continues. The new metallurgical research technique developed is thought to be of significant help in bringing along the great variety of new metals and alloys which inevitably will be demanded by the bigger, stronger, and more efficient equipment of the future.

Franklin's Method Breaks Tape To Open Plant

AS A TRIBUTE to Benjamin Franklin whose 250th birthday is being recognized this year by organizations throughout the world, a demonstration of combined 18th and 20th century electrical instruments was arranged in co-operation with the Franklin Institute.

Introducing the Franklin theme, I. Melville Stein first pointed out that Franklin studied many of the electrical phenomena used in Leeds and Northrup Company (L&N) instruments. The speaker then invited an actor dressed to resemble the statesman-scientist to join the group.

A four-day open house at the new instrument-manufacturing plant of Leeds and Northrup Company got under way in the Philadelphia suburban town of North Wales, Pa., when Mr. Stein, president of L&N, directed that a "magic tape" be ignited to unseal, officially, the main entrance to the plant.

The entrance had been sealed by a "magic tape," connected through a spark device to a spherical electricity-receiving terminal, an L&N amplifier and a Speedomax recorder.

"Franklin" advanced, bearing a replica of a glass tube actually used by his famous predecessor, and loaned especially for the occasion by the Franklin Institute. Rubbing the tube with a cloth to generate static electricity, "Franklin" brought it near the sphere. The sphere instantly developed an electric charge on its own surface. The Amplifier stepped the charge up enormously, the Speedomax recorder's pointer spun upward, a firing device spat blue-white sparks, and a flash of flame shot along the tape, unsealing the doorway.

Guests included prominent industrialists and scientists as well as employees of L&N, and their families. It was explained that security regulations did not permit invitations to the general public.

Guests spent up to two hours touring the modern instrument plant, which will be devoted entirely to manufacture of Speedomax recorders and recorder controllers, Metermax combustion controls, L&N load-frequency controls, and certain other automatic instrumentation widely used by science and industry. Manufacturing operations employ punch presses, turret lathes, automatic and hand screw machines; drill presses, milling machines, engravers, coil winders, plastics molding, and casting machines. Typical operations are heat-treating spraying and lacquering, connecting, calibrating, testing, assembling, and tool and die making.

Because of the wide variety of products, it was pointed out, mass-production techniques are seldom used, but great emphasis is placed on proper sequence and arrangement of operations, efficient tooling and other measures to assure economy of production and maintenance of quality. Inspection operations are performed "in the flow of production" wherever possible.

The manufacturing and office areas are a single-story building with partial mezzanine, providing over 6 acres of floor space and set in a 129-acre tract. Walls are of brick and insulated metal siding, with glare-resistant windows. The flat roof is also insulated and can hold several inches of water for additional summer-time insulation and cooling. A forced-convection system with huge ducts and outlets provides ventilation and heating by means of up to half a million cubic feet per minute of low-velocity air; the building is designed to operate with windows closed, winter and summer.

Special heating and ventilating systems are provided for such areas as heat-treating and paint-spraying, where requirements in these respects differ greatly from the rest of the plant. Likewise, the punch-press section floor is vibration-insulated from surrounding areas.

A separate power plant, with a pair of 30,000 pound per hour surface combustion boilers, provides heating and process steam at about 125 psi. It uses about 500,000 gallons of No. 6 fuel oil a year. Connected electric load is about 700 kw, purchased from Philadelphia

Future Meetings of Other Societies

Air Force Association, 1956 National Convention and Airpower Panorama, August 1–5, Roosevelt Hotel, New Orleans, La.

SAE, West Coast Meeting, August 6–8, Mark Hopkins Hotel, San Francisco, Calif.

ASME, Heat Transfer Division National Conference, August 11–15, Pennsylvania State University, University Park, Pa.

Scientific and Technical Writing Conference, August 20–24, University of Pennsylvania Institute for Co-operative Research, Philadelphia, Pa.

Western Electronic Show and Convention, August 21–24, Pan Pacific Auditorium, Los Angeles, Calif.

ASCE, National Hydraulics Division Annual Meeting, August 22–24, University of Wisconsin, Madison, Wis.

National Council of State Boards of Engineering Examiners, 35th Annual Meeting, August 23–25, Hotel Statler, Los Angeles, Calif.

Association for Computing Machinery, Annual Meeting, August 27–29, Westwood Campus Los Angeles, Calif.

National Metal Trades Association, September 9–12 Essex-Sussex Hotel, Spring Lake, N. J.

AIChE, National Meeting, September 9–12, Pittsburgh, Pa.

Electron Microscope Society of America, September 9–12, Madison, Wis.

Information Theory Symposium. September 10–12, Massachusettes Institute of Technology, Cambridge, Mass.

Titanium Lecture Program, 2nd Annual Series, September 10–14, New York University College of Engineering, University Heights Campus, The Bronx, N. Y.

ASME, Fall Meeting, September 10–12, Cosmopolitan Hotel, Denver, Colo.

Transport Phenomena in Metals, September 10–14, International Union of Pure and Applied Physics, National Research Council, Ottawa, Ont., Canada.

RETMA, Symposium on Reliability of Electrical Connection, September 11–12, University of Pennsylvania, Philadelphia, Pa.

2nd Conference on Reliable Electrical Connections, RETMA, September 11–12, Irvine Auditorium, University of Pennsylvania, Philadelphia, Pa.

Reaction Mechanisms Conference, September 12–15, Swarthmore College, Swarthmore, Pa.

Conference on Communications, IRE Cedar Rapids Section, September 14–15, Roosevelt Hotel, Cedar Rapids, Iowa.

ASTM, 2nd Pacific Area National Meeting and Apparatus Exhibit, September 16–22, Hotel Statler, Los Angeles, Calif.

Instrument Society of America, Conference and Exhibit, September 17–21, New York, N.Y.

American Transit Association, Annual Meeting, September 17–20, Jefferson Hotel, St. Louis, Mo.

Illuminating Engineering Society, National Technical Conference, September 17–21, Hotel Statler, Boston, Mass.

11th Annual International Instrument-Automation Conference and Exhibit, September 17–21, Coliseum, New York, N. Y.

PGNS-IRE, Annual Meeting, September 20–21, Mellon Institute Auditorium, Pittsburgh, Pa.

National Electrical Contractors Association, Annual Convention and 2nd Exposition, September 23–29, Sheraton-Palace Hotel, San Francisco, Calif.

Atomic Industrial Forum, 1956 Trade Fair, September 24–28, Navy Pier, Chicago, Ill.

Audio Engineering Society, Annual Meeting and New York High-Fidelity Show, September 27–30, New York Trade Show Building, New York, N. Y.

National Electronics Conference and Exhibit, October 1–3, Hotel Sherman, Chicago, Ill.

Heating, Piping, and Air-Conditioning Contractors National Association, The Mechanical Contractors Association of America, Fall Meeting and Conference, October 1–3, Hotel Statler, Detroit, Mich.

American Mining Congress, Metal Mining Industrial Minerals Convention and Exposition, October 1–4, Shrine Exposition Hall, Los Angeles, Calif.

Porcelain Enamel Meeting, ASTM Committee C-22, October 2–3, Battelle Memorial Institute, Columbus, Ohio.

"BENJAMIN FRANKLIN" has ignited "magic tape" across entrance by rubbing silk cloth on glass tube charging its surface with static electricity. I. M. Stein, president of L&N makes opening address.

Electric Company, at 34,400 volts to substations, and distributed at 480 volts to the plant's various areas. The 3,200 electric light fixtures have about 7½ miles of fluorescent tubing. Water consumption is about 105,000 gallons per day, of which 20,000 gallons of potable water are bought from the Borough of North Wales and the rest secured from wells on L&N property.

In-plant communications feature three special systems, in addition to Bell Telephone services. There is a central time-keeper system, a supervisory safety-monitoring system, and a broadcasting, music-playing, signal-handling network especially devised by L&N engineers and called, somewhat cryptically, "Safetemp."

Safetemp lets anyone with proper authority talk or signal to practically any plant area—it's just that broad. It has voice paging from in-plant, and signal paging from either in-plant or from headquarters offices and plant 16 miles away; with overriding priorities for plant-protection guards, for fire signals, and for executive communications, in that order. It includes a 100-record player, and facilities for setting up a full week's schedule of intermittent music over the plant's public address system, to selected areas.

The opening address by Mr. Stein referred to the modern nature of the instruments to be produced, and pointed out that they stem from the world's first successful null-balance recorder of 1912, redesigned as an electronic instrument in 1932 and known as Speedomax from that time. Mr. Stein paid tribute to Benjamin Franklin as a good citizen and a seeker after fundamental truths "whether in science, human relations, Government, or business," and saw in Franklin's example an indication of what his own firm may do to help "raise the standard of living today and tomorrow."

Autopilot and TV-Equipped Aerial Drone

Details of a unique new autopilot now being used as part of a drone control system by the United States Army Signal Corps were announced by Temco Aircraft Corporation.

The president of Temco, Robert McCulloch, said that the company developed the autopilot for remote control of six *L-17* drones which the Dallas, Tex., firm is delivering, along with three ground control stations, to Signal Corps laboratories.

In addition to the autopilot a television pickup from the experimental aerial drone system designed to aid combat commanders in getting an immediate ground evaluation was announced by the Department of the Army.

Live television shots can be made of strategic territory by using the pilotless system and then broadcast to a ground control station. The converted *L-17* planes being used currently will cover a 25-mile area, which later will be augmented by using radar.

Results will be "instantaneous for immediate ground evaluation" with unlimited potentialities according to Signal Corps Engineering Laboratories' scientists.

The 250-pound ground station is weather and shock resistant. It includes radio links for commanding the drone and for communicating with a safety pilot. Still photos may also be made using this system.

The pilotless system for evaluating the performance of photographic and television cameras in droned surveillance missions consists of an *L-17* aircraft modified for photo-television-drone operation; a unique autopilot which provides effective remote control of the drone. The basic *L-17* aircraft was flight-tested to determine its exact response to controls; basic design for the drone system was completed; off-the-shelf autopilot components were selected and ordered, and the prototype was fabricated.

The modified *L-17* may be used as a pilotless aircraft, operated from the ground, or it may go aloft with a safety pilot who can operate the aircraft himself, or turn command over to a ground controller.

By actuating pilot control switches on the ground, the controller can maintain complete out-of-sight command of the *L-17*.

Signals transmitted from the ground station to the *L-17's* 42-pound auto-pilot "brain" regulate stability, altitude and airspeed. Obeying remote commands, the aircraft will perform a programmed climb or glide, and special control provisions prevent stalls, over-speeding, excessive loss of altitude and other hazardous conditions.

The controller's 250-pound ground station is weather- and shock-resistant and includes radio links for commanding the drone and for communicating with a safety pilot.

The company also prepared technical manuals covering operation of the system for use by the Signal Corps.

Temco engineers developed the autopilot from preliminary design to first flight in less than six months. Although its function is similar to certain complex missile control systems, it is much more simple in design. It contains standard off-the-shelf components and employs the maximum of simplicity of circuitry.

Most unique among the control system's simplicity features is the manner in which it regulates the degree of any maneuver which the pilotless aircraft is directed to performs.

A common method of regulating degree of maneuver is to vary the intensity of the signal which transmits the command. In the new system, the same control is achieved by ON-OFF radio signals.

For example, the drone begins executing a prescribed maneuver as soon as the radio command is received.

The degree of the maneuver—a bank, for example—increases as long as the signal continues. The maneuver is halted and held at the desired degree by stopping the command signal. Limit stops in the system guard against inadvertant overcontrolling or over-speeding of the drone.

Signals which actuate the autopilot are coded and transmitted from a 250-pound ground station. This unit is weather and shock resistant and may be transported in a jeep.

In the drone, a radio receiver and decoder receives and passes on commands to the autopilot coupler. This unit—the brain of the autopilot—feeds the commands to applicable servos which actuate the drone's control surfaces, landing gear, propeller pitch, throttle, flaps, and observation equipment.

The autopilot automatically regulates the drone's stability, altitude, and airspeed. Obeying remote commands, the aircraft will perform programmed climbs or glides and co-ordinated turns or rudder turns.

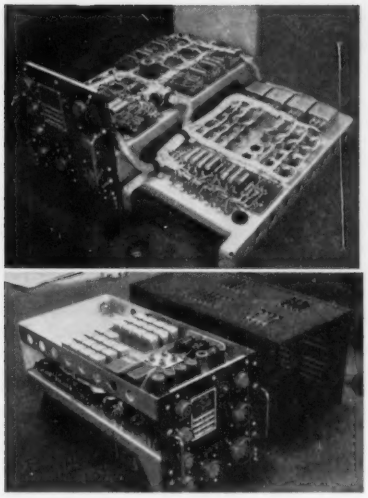
Even carburetor heat is automatically controlled. Heat is turned on any time carburetor air temperature drops below 65 F while landing gear is retracted.

When the drone's mission is completed, the ground controller flicks an "approach" switch which automatically positions landing gear, flaps, prop pitch, and power in proper sequence for landing. Then he directs the aircraft onto the runway for the pilotless landing.

Four drone aircraft and two ground con-

U. S. Army Photograph

ARMED FORCES DAY demonstration at Bolling Field of the aerial drone television broadcast pickup.



DRONE SYSTEM (right) shown with all components. On ramp below the drone *L-17* are airborne elements of the system. Cabinet on legs to right of airborne units is ground control unit for pilotless aircraft. Drone system brain (*top left*) is autopilot coupler, main computing element in drone system. The 42-pound unit takes sensing signals sent from the ground and decodes them in the drone. Then it sends commands which control drone's flight. Circuitry inside autopilot coupler (*bottom left*) is exposed showing main computing element.

trol stations already have been delivered to the Signal Corps laboratories at Fort Monmouth, N. J., and also at Fort Huachuca, Ariz.

Six Signal Corps pilots were trained by the company for ground and air operation of the drone system.

Microwaves Used in Meteorological Studies

The United States Army Signal Corps has a means of seeing around corners of the earth as microwave transmissions travel "beyond the blue horizon" at the Army Electronic Proving Ground, Fort Huachuca, Ariz.

Normally, ultrahigh frequency microwave transmissions, such as used in television broadcasts, can travel only from the transmitting point to the horizon, or within the line of sight. However, certain atmospheric conditions cause "ducting," a phenomenon enabling the waves to bend, and return to the earth beyond the line of sight.

Special Studies Branch, Plans and Programs Division, Aviation and Meteorological Department, AEPG, is currently using airborne electronic equipment to analyze the effects of temperature and humidity changes on microwave transmissions.

A duct is a layer of atmosphere, either based at the earth's surface or aloft. It contains, between its highest and lowest levels, abnormal temperature and humidity conditions. The usual vertical dimension of a duct ranges from 10 to 100 feet, although, as some tests made by the Special Studies Branch, AEPG, revealed, some ducts have been measured from 100 to 500 feet.

Usually temperature and humidity decrease as the altitude increases. But, when the temperature increases with height, and the humidity decreases at a faster than normal rate, meteorological conditions are then ideal to cause "ducting."

Predictions being made by the Aviation and Meteorological Department as to what frequencies are affected by the ducts and to what degree and distance these wavelengths can be used, are utilized by the Electronic Warfare, Battle Area Surveillance, and Engineering and Technical Departments in their projects at the AEPG.

The greater the vertical dimension of a surface base duct, the greater the range of frequencies affected. A friendly radio or television station in a tactical position can regulate the distance of its transmission to exclude enemy receivers beyond the line of sight. The use of frequencies that are not affected by the duct will accomplish this, according to the Fort Huachuca's meteorology department.

Sometimes when a surface base duct is being used and both friendly and enemy receivers are beyond the horizon and somewhat close to each other, a decrease in power is necessary to eliminate the more distant, enemy station.

Another useful duct for ground-to-ground communication, as disclosed by Aviation and Meteorological Department is one that is aloft, its base being above the transmitting and receiving stations. As a beam of waves is emitted from the transmitting antenna, only those forming an angle of less than one degree with the base of the duct are deflected back, and extend beyond the line of sight. The others are refracted and continue skyward, their course slightly altered by the changes in density.

Inasmuch as only a small fraction of the transmitted waves revert to the ground, and the angle of deflection under one degree can be controlled by changing the wavelength being transmitted, a knowledge of the height of the duct is primarily all that is needed to calculate the distances that can be transmitted at different frequencies.

It is these calculations, tests and experiments by the AEPG's meteorologists that are aiding the Signal Corps to transmit beyond the line of sight, and in effect, to "see" around corners of the earth.

India Dedicates First Newsprint Mill

Formal dedication and opening ceremonies were held recently for the first mill in India to manufacture newsprint. The dedication was attended by many Indian dignitaries, including Prime Minister Jawaharlal Nehru, who was on hand for the opening of this modern, integrated newsprint mill.

Ebasco Services Inc. designed and supervised construction of the mill, which was built for the National Newsprint and Paper Company, Ltd., of Bombay. It is located at Nepanagar, near Chandni in the State of Madhya Pradesh, Central India.

The $12 million project marks the first such enterprise on the mainland of Asia and the only modern one in the world designed and constructed to process newsprint for the first time commercially from bamboo and salai trees. Approximately 11,000 square miles of timberlands are available in Madhya Pradesh to provide a continuous supply of pulpwood.

Prime purpose of the new mill is to meet the acute shortage of newsprint and to conserve dollar exchange in India. The project also represents one of India's first postwar industrial projects and is an essential part of the over-all industrialization plans for that country.

Its anticipated annual output of about 35,000 tons of newsprint is expected to go a long way toward relieving the scarcity of that vital commodity in India. Previously, Indian newspapers were forced to import newsprint from Canada or Scandinavia, and school books had to be printed in other countries, all at great cost.

The installation includes Groundwood, Chemical Pulp, and Paper Machine Divisions, storage and shipping buildings, and workshops.

Applied Solar Energy Library Now in Operation

A library devoted exclusively to solar energy is now in operation at headquarters of the Association for Applied Solar Energy, 204 Heard Building, Phoenix, Ariz.

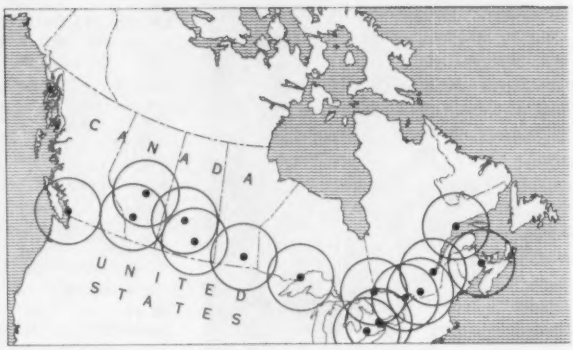
The library contains more than 2,500 references in the form of technical papers, articles, and patents, all dealing with solar energy research and development. Also in the library are the few books which exist

today on the broad subject of solar energy.

Of these references, 1,500 are listed in "Applied Solar Energy Research," the bibliography-directory published for the Association by Stanford Research Institute early in 1955. An additional 1,000 references have been added during 1955 and 1956.

Among the most important new additions to the library are the 32 papers presented at the World Symposium on Applied Solar Energy in Phoenix, and the 96 papers delivered at the Tucson Conference on the Scientific Basis of Solar Energy.

Current activities of the Association, in addition to the operation of the library, include the publishing of two official periodicals, the quarterly newsletter, *The Sun at Work*, and the *Journal of Solar Energy, Science and Engineering*.



RADAR installations at 15 major Canadian airports: Moncton, Seven Islands, Quebec, Montreal, Ottawa, Toronto, London, North Bay, Fort William, Winnipeg, Regina, Saskatoon, Edmonton, Calgary, and Vancouver.

Canadian Transcontinental Air Traffic Control System Set

During the past year a number of new major construction projects have contributed substantially to the further development of the Canadian system of airports and airways. Better facilities are available for the traveling public and for the airlines serving Canada.

The first task undertaken by the Department of Transport in the immediate postwar years was the development of runways adequate to meet the needs arising from the rapid growth of civil aviation. In recent years, the national network of civil airports had been brought to a point where planes in standard commercial use could land at any of the main Canadian airports. Others are under construction, and more are to be started both during 1956 and 1957, tapering off by about 1960.

High intensity lighting for both approach and runway purposes have been installed throughout. The installation of a center line approach system of high intensity lights, which fits in directly with military aviation requirements as well, is now close to completion. During the same period, instrument landing systems (ILS) have been installed as the standard instrument landing aid at Canadian airports. The program for installation of VOR ranges on the transcontinental airways also is well advanced.

A special study was made by Canada's civil aviation authorities of the question of land requirements for future construction and expansion of airports; and also of protection of airports from building obstructions in the vicinity. Following a review of land requirements to provide for expansion of major transcontinental airports over the next 25 years of growth, the Canadian Department of Transport was authorized to proceed with an extensive program of land acquisition.

Special airways equipment is necessary with the growing volume of civil and military flying. Adequate separation of aircraft on the airways and particularly on the approaches to airports is greatly aided by radar coverage which shows the exact position of aircraft in relation to each other.

The new radar equipment is built for long-range, high-altitude detection of aircraft, giving a radar coverage of approximately 400,000 square miles; a major step forward in traffic control.

Air traffic controllers at each of these 15 airports will be able to detect small aircraft within a radius of 100 statute miles, and at an elevation up to 60,000 feet. Large aircraft can be detected within a distance of 135 statute miles.

The new long-range surveillance radar will assist in providing separation for aircraft on the airways leading to or from the airport, with a scope or indicator in the tower so that the personnel in the tower can control the aircraft and direct its landing or take-off and other operations in the vicinity of the airport.

The use of radar for air traffic control has been developed only in recent years and its adaption to civil aviation has hitherto been somewhat limited. Use of long-range surveillance radar will assure greater safety for aircraft operating in controlled airspace, enable air traffic control personnel to identify and track aircraft under all weather conditions, and expedite the flow of controlled air traffic.

The Department of Transport also is installing on its own aircraft relatively high intensity rotating anticollision lights to determine their efficiency in increasing visibility at night in relation to other aircraft in the area. Also under study is the advantages of airborne storm warning radar, although its use in Canada appears less urgent than in other countries where violent storm conditions are more frequently encountered.

A light-weight and relatively inexpensive piece of radar equipment for use in an emergency to facilitate search and rescue work is being installed in aircraft. It is hoped that by reason of this device aircraft that have landed in or out of control in an emergency may be spotted from the air by aircraft carrying the appropriate receiving equipment.

Two refresher training courses are given in which senior instructors from all across Canada are supplied with up-to-date information on accepted training procedures, inasmuch as the greatest single contribution toward good flying is a high standard of skill among pilots.

AIRPORT and airways surveillance radar, capable of tracking airliners within a radius of up to 200 miles. Geographic indications permit operator to pinpoint positions of planes electronically with system's built-in ability to select and reflect only moving objects.

RETMA Gives Definition of "Automation"

The Radio-Electronics-Television Manufacturers Association (RETMA) announced today the formulation of a realistic and comprehensive definition of the term "Automation" in response to an urgent need expressed by the electronics industry which is deeply involved in the new manufacturing process but is lacking in a common, unified definition.

RETMA's definition reads:

> "Automation is the technique of improving human productivity in the processing of materials, energy and information by utilizing, in various degrees, elements of self-control and of

automatically executed product programming."

The RETMA Engineering Department's staff committee on automation, under the chairmanship of Walter Hausz, General Electric Advanced Electronic Center, formulated the foregoing definition.

In an explanation of certain of the words used, the RETMA Committee said: "human productivity" is a positive statement of purpose which is a more accurate description of the concept than the negative statement "elimination of human intervention," and the broad field of industrial endeavor from basic material to the final end-product is covered by the words "processing of materials, energy, and information."

Continuing, RETMA said that the concept of automation is not meant to be transitory. Thus, the more stable term "utilizing" instead of "adding" is used. "Automatically executed product programming" is a key factor which describes the adaptability to change in product which is basic to the automatic factory; the word "programming" was chosen as the broadest term whose popular interpretation would convey the basic meaning, and "automatic execution" is a qualification which discourages an "all manual" interpretation.

Gun Camera Emulates Iris of the Human Eye

Details of a new type of target analysis or "gun camera," which emulates the iris of the human eye in that it automatically compensates for changes in light conditions, have been revealed by the United States Air Force (USAF).

Designated the *KB-5*, the camera was designed and engineered by Fairchild Camera and Instrument Corporation, Syosset, N. Y. The company also built the prototype models, which are now undergoing final flight testing by the USAF at Wright-Patterson Air Force Base.

These motion picture cameras, installed on supersonic jet fighter planes, can be used to record details of aerial combat. The importance of automatic exposure control can be readily understood when it is realized that the nose of such a plane, engaged in a "dog fight," may be pointed at brilliant sunlight sky, and a few seconds later at a densely shaded area of the earth, as it maneuvers into firing position. In former cameras of this type, this meant that portions of the film would be greatly overexposed while other sections would be underexposed.

In the *KB-5* the actual illumination received through the picture taking lens can be compared 64 times a second with the illumination from a reference lamp inside the camera. If there is a difference, the lens diaphragm is changed to match the light level of the reference lamp which insures proper film exposure. This is accomplished by a closed loop system, employing a transistor servo amplifier. The rate of response to a change in light is rapid. The system will drive 6 lens stops in 1.8 seconds.

Another feature of the *KB-5* is its extremely light weight. The camera, with a fully loaded magazine containing 50 feet of film, weighs less than $5^1/_2$ pounds.

New concepts of film handling are also employed. The unique film drive is contained in the film magazine itself. It is always engaged with the film and there are no clumsy claws to be bent or which lose contact with the film during the return stroke. Provision is made for daylight loading of the cameras, employing a standard 50-foot film cartridge.

The shutter speed is 1/250 of a second. This speed cannot vary with changes in frame rate as the shutter design entails two blades each rotating in the same direction. The forward blade, or shutter blade, has an angular cutout of 92 degrees and rotates at a constant speed of 64 revolutions per second. The second blade, has a 115-degree angular cutout and rotates at the same speed as the frame rate—64, 32 or 16 frames per second. With this arrangement, the required shutter speed is maintained without the necessity of varying slit width as in the conventional type shutter design.

Split-Channel and Co-Channel Arrangements

During the annual meeting of National Committee for Utilities Radio (NCUR) April 23-25 in Omaha, Neb., 94 representatives of regional and trade associations heard reports of continuing requests for frequency recommendations received by frequency co-ordinators in nearly all regions. Co-channel arrangements often have been the only answer to such requests in the 30–50 mc and 152–162 mc bands. Little use has been made of the higher bands for mobile systems partly because assignment in them has been on a developmental basis shared with other services.

Reports were presented to the meeting on comments submitted by NCUR to the Federal Communications Commission (FCC) on five dockets now before the FCC. Considerable discussion arose on one of these, i.e., Docket *11253*, the Split Channel proposal. The members were warned that no assurance has been afforded that new channels made available by split channel operation will be allocated to the service to which the original unsplit channel was allocated.

The executive council was directed to form a working group to study new uses of radio by the utilities to increase the efficiency of their operations. It was reported that following a directive from the previous annual meeting the council has petitioned the FCC for a rule change to permit use of power radio service manned base and mobile stations on an incidental basis to send coded tone signals to fixed receivers to perform control functions.

Depth-of-Anesthesia Measured Electronically

A positive means of measuring the depth of anesthesia during surgery has been announced recently by the Edin Company with the introduction of the "Anesthograph."

The instrument is described as being a compact unit for clinical use in the operating room to monitor the amount of anesthesia absorbed by the patient and to record his heart condition. The Anesthograph simultaneously records brain-wave patterns from an electroencephalograph and the heart-action tracings from an electrocardiograph, all of which is incorporated in the one instrument.

Anesthesiologists conventionally determine how deeply they have put their patients to sleep by relying on their experience and observations of pulse rate, blood pressure, and respiration. With the new instrument, a positive indication of brain activity is provided, which is translated onto anesthesia level. Extensive research, testing, and actual operating room experience have established the accuracy and reliability of the instrument for quickly determining danger signals not apparent to the anesthetist who up until now has had to rely on visual observation. Anoxia, or oxygen starvation in the brain tissue, becomes readily apparent from the Anesthograph readings before this condition could cause irreparable damage or death.

The close control of anesthesia which is made possible by this instrument will increase the practicability of surgery on many patients who, under ordinary conditions, would be considered poor surgical risks. The Edin Company has prepared a bibliography of articles written by outstanding anesthesiologists covering this subject. This list of articles, together with full details on the new machine, is available from the Edin Company, Inc., 207 Main St., Worcester, Mass.

Resurrecting of Specialized Information

Classified outlines of subject matter in specialized fields of knowledge currently are being collected by the Special Libraries Association. Such classifications are of tremendous help, not only to librarians but also to researchers, scientists, and others concerned with organizing the literature in their particular fields of interest.

The Special Libraries Association maintains a "loan collection" of such classifications on subjects ranging from "accounting" to "wood." The collection includes both the natural and social sciences in broad categories such as chemistry, physics, and law, and also in narrower subdivisions such as "entomology," "radiology," and "steels."

This collection of classification schemes is being brought up to date and expanded, and contributions for all fields of knowledge are being solicited. Such contributions can be donated either on a permanent basis or on loan.

The collection is housed at the School of Library Science, Western Reserve University, Cleveland, Ohio. Plans are under way to supply microfilm or photostat copies at a nominal fee.

The work of enlarging the collection and bringing it up to date is under the direction of the Committee on Special Classifications of the Special Libraries Association. Dona-

tions of classifications or requests for further information should be addressed to: Allen Kent, *Chairman*: Committee on Special Classifications, SLA; c/o School of Library Science; Western Reserve University; Cleveland 6, Ohio.

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ASTM STANDARDS ON COPPER AND COPPER ALLOYS. Published by The American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1955. 637 pages, 5⅞ by 8⅞ inches, paper. $5.75. These standards cover copper, copper-alloy, and copper-covered-steel electric conductors; primary forms of copper, zinc, lead, and nickel used in the manufacture of copper-alloy products; copper and copper-alloy pipe, tube, and wire; copper and copper-alloy castings; and other products. A subject index is provided for convenience of reference.

ASTM STANDARDS ON METALLIC ELECTRICAL CONDUCTORS. Published by The American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1955. 298 pages, 6 by 9 inches, paper. $3.50. This publication presents in convenient form, for reference, the various specifications and methods of tests for metallic conductors, whether for use in uninsulated or uncovered form or for use in making insulated or covered conductors. Among the products covered are wire and stranded conductors of copper or aluminum copper bus bars and tubes, iron and steel guy wire, and galvanized steel core wire.

ANALYSIS OF ELECTRIC CIRCUITS. By W. H. Middendorf. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1956. 306 pages, 5¾ by 9¼ inches, bound. $6. Impedance and admittance, circuit parameters, equivalent series, locus diagrams, resonance phenomena, magnetic field coupling, and other basic topics are covered in the first part of this introductory text. In the remaining two parts, the treatment is extended to polyphase and communication circuits, network theorems and simplifications, and the analysis of nonsinusoidal waves.

APPLIED GROUP-THEORETIC AND MATRIX METHODS. By Bryan Higman. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y., 1955. 454 pages, 6 by 9⅛ inches, bound. $9.60. The first two parts of this advanced text for physical scientists are devoted to the theory of finite groups and to applications of finite groups to crystal forms, crystal structures, and the vibrations of molecules. The last part of the book—about half the contents—covers the theory of continuous and of symmetric groups, symmetry types in tensors, tensor properties of crystals, the relativistic origin of spin, quantum theory, the analysis of molecular orbits and spectra, and Eddington's fundamental theory.

COLLOQUIUM ON FATIGUE. (International Union of Theoretical and Applied Mechanics, Stockholm, Sweden, 1955.) Edited by W. Weibull and F. K. G. Odqvist. Springer-Verlag, Berlin, Germany, 1956. 339 pages, 6¼ by 9⅜ inches, bound. DM 46.50. The present volume contains the 35 papers presented at the Colloquium in full, with discussions. Among the topics are statistical theory of fatigue, cumulative damage, mechanism of fatigue, velocity of fatigue cracks, fatigue at elevated temperatures, and fatigue at combined stresses. About half the papers are in English, the remainder in French or German. The subject index is given in all three languages.

ELECTRONS, WAVES AND MESSAGES. By J. R. Pierce. Hanover House, Garden City, New York, 1956. 318 pages, 5½ by 8½ inches, bound. $5. An explanation, for specialists in other fields and for the general reader, of the principles of modern electronics and their applications, chiefly in long-distance communication and radar. The author reviews some of the basic laws of physics concerning motion, electric and magnetic fields, and waves; shows these at work in such devices as transmission lines, resonators, antennas, and vacuum tubes; and explains how these components are combined in microwave systems. Other subjects discussed include television, communication theory, relativity, and quantum mechanics.

ELECTRONICS IN MANAGEMENT. Edited by L. H. Hattery and G. P. Bush. The University Press of Washington, D. C., Washington 9, D. C., 1956. 207 pages, 5½ by 9¼ inches, bound. $6. Adapted from the proceedings of the First Institute on Electronics in Management, this volume consists of a number of separate papers presented under the following broad headings: management impact, equipment, case examples, and suggestions for management. Among the problems discussed are costs, evaluating and selecting equipment for data processing, procedural changes for electronic equipment, and preparing employees for the changeover. The case studies describe the experience of the Census Bureau, Air Force, and Aviation Supply Office with installed equipment, and a feasibility survey conducted by the Treasury Department. A brief selected and annotated bibliography is included.

PAMPHLETS

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

Ten-Year Index to Corrosion, 1945–54. Publication Number *56-10*, 32 pages, compiled by N. E. Hamner and J. F. Van der Henst, Jr., May 1956. The alphabetical subject index consists of approximately 4,000 reference phrases and alphabetical author index of 1,056 names. Titles are included of 629 articles published in the first decade (1945–54) of publication of *Corrosion*, the monthly journal of the National Association of Corrosion Engineers (NACE). The subject index, organized around the system developed for the NACE Abstract Filing Index, is intended to be of maximum service to the general corrosion worker. No effort was made to limit the number of cross references, with the result that there is more than one reference per page of indexed material. The index is characterized by a wide variety of subject matter with data on pipeline and petroleum corrosion problems in greater volume than other topics. Of special interest to corrosion engineers are the numerous tables of data. Published by the National Association of Corrosion Engineers, 1061 M and M Building, Houston 2, Tex. $5 per copy, postpaid, NACE members. All others, $7.50. Add 65¢ for Book Post Registry to addresses outside the United States, Canada, and Mexico.

Capacitor, Variable, Hermetically Sealed, Three Sections. Research conducted in an attempt to produce an hermetically sealed, oil filled, three-gang tuning capacitor for the U. S. Signal Corps is reviewed in detail in a report just released to industry through the Office of Technical Services (OTS), U. S. Department of Commerce. Although it was concluded that mechanical tolerances, particularly of ceramic parts, necessary to obtain the required performance made it impossible to achieve the ultimate goal, there is recorded in the report a vast amount of data believed to have substantial value in related fields, such as fixed capacitors, air dielectric concentric trimmer capacitors, and ceramic dielectric capacitors. Extensive measurements taken on the materials and the analysis of the geometric combinations of such materials will be a useful reference in future research and development programs. 139 pages, illustrated. This report, *PB 111961*, by Sprague Electric Company for U. S. Signal Corps, is available from OTS, U. S. Department of Commerce, Washington 25, D. C., price $3.50.

Supervisors' Safety Manual. Written by staff engineers of the National Safety Council's industrial department and carefully reviewed by safety experts from business, industry, and Government, the manual provides foremen with a comprehensive guide to all phases of industrial safety. It can be used as a text for group training or self study, or as a reference work to solve most of the general safety problems encountered by the foreman in his work day. The manual includes material on the human side of safety, maintaining interest in accident prevention, first aid, protective equipment, housekeeping, materials handling, machine guarding, portable power tools, and fire prevention. 354 pages, illustrated with numerous photographs and drawings. Available to Council members for $3.25, nonmember price is $7.50. For further information write the National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.

Mechanical Properties of Wrought Phosphor Bronze Alloys. ASTM Special Technical Publication No. *183*. This paper shows the effect of cold-working on the mechanical properties of a series of eight phosphor bronze alloys in two conditions in the form of cold-rolled strip with varying tin content from 0.5 to 10.0 per cent. Electrolytic tough pitch copper strip similarly treated is included to provide a base for evaluating the effectiveness of the tin additions. The mechanical properties—including tensile strength, proportional limit, yield strength at both 0.01 to 0.2 per cent offset, modulus of elasticity, elongation, bending fatigue characteristics lifetimes ranging from 100,000 to 100 million cycles and the Rockwell Hardness (B and 30 T values)—are reported for six different tempers of each of the materials. Copies of this 120-page publication can be obtained from American Society for Testing Materials Headquarters, 1916 Race Street, Philadelphia 3, Pa. Price, $3.

Boilers and Combustion, 1955. This report includes the results of the survey conducted by the Boilers and Combustion Subcommittee of the Edison Electric Institute Prime Movers Committee covering the operation, service, and maintenance of steam generators. It also contains statements from four of the leading manufacturers of steam generators. The Subcommittee section includes statements under the following headings: Pressure-Fired Boilers, Outdoor Boilers, Controlled (Forced) Circulation Boilers, Plastic Versus Steel Encased Settings, Cutting of Steam Generator Tubes by Fly Ash, Superheated and Reheated Steam Temperature Control, Cyclone-Fired Boilers, Soot Blowers and Boiler Cleaning, Rate of Load Pickup on Boilers, and Superficial Pressure Units. This publication, No. *55-22*, may be obtained from the Edison Electric Institute, 420 Lexington Ave., New York 17, N. Y. 22 pages, 75¢ to members and their employees, $1.90 to nonmembers in the United States, $2 to foreign countries.

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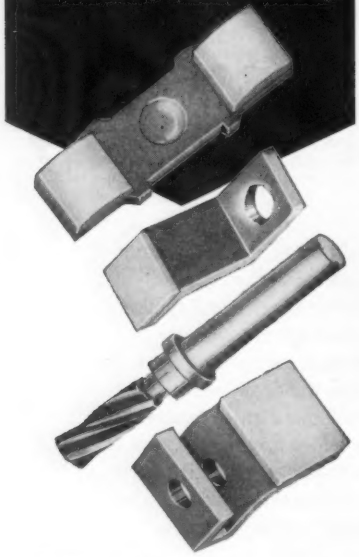

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INDUSTRIAL NOTES ...

Accelerator for Nuclear Research. A 2-million-volt Van de Graaff particle accelerator for nuclear research in the petroleum industry has been purchased by Magnolia Petroleum Company for use in its Field Research Laboratories in Dallas, Tex. The new machine will be horizontally mounted and will be used basically to produce neutrons for petroleum studies extending the work that can be done beyond the capabilities of the one-half million-volt unit. Van de Graaff particle accelerators are manufactured by High Voltage Engineering Corporation, Cambridge, Mass.

Clary Given Trusteeship. Election of H. L. Clary to the board of trustees of the new Harvey Mudd College of Claremont, Calif., has been announced. Mr. Clary received his bachelor of arts degree in 1915 from Pomona College, Claremont, Calif., where he majored in mathematics, and did graduate work at Carnegie Institute of Technology, Pittsburgh, Pa. Prior to the 1939 founding, the Clary Corporation of San Gabriel, Calif., which manufactures business machines, data handling equipment, and aircraft and missile components, he was vice-president in charge of operations of the Bank of America in San Francisco, Calif.

Medical Research Center. The Atomic Energy Commission's New York Operations Office announced today the award of contracts for construction of a Medical Research Center including the first nuclear reactor designed specifically for medical research and therapy at Brookhaven National Laboratory, Long Island. Daystrom Nuclear Division of Daystrom, Inc., Elizabeth, N. J., will supply and install the reactor, including the core, process instruments, console, and wiring to Brookhaven. The reactor will be housed separately in a steel building. The one story medical center will house research laboratories for medical physics, pathology, microbiology, biochemistry, and physiology, a 48-bed research hospital, and an industrial medicine branch for Brookhaven personnel.

New Plant Dedicated. A new industrial heating department plant has been put on stream at Shelbyville, Ind., by the General Electric Company. There has been a trend to more continuous automatic heat treating in every phase of industry. There will be considerable improvement in other processes also. Vacuum arc melting, currently used with metals such as molybdenum, zirconium, and titanium, will be utilized more and more with plain steels

(*Continued on page 18A*)

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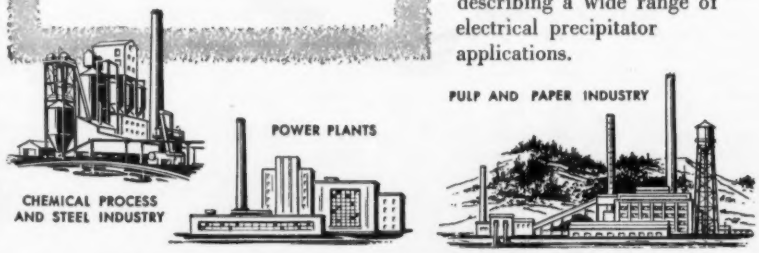

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KR Voltage Regulated Power Supplies are conservatively rated and are designed for continuous duty at 50°C ambient.

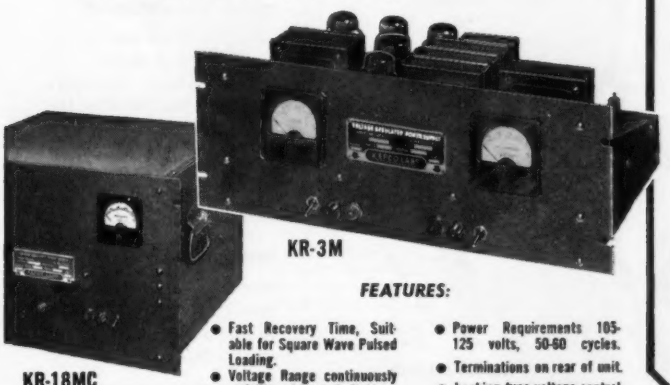
REGULATION: Less than 0.2 volts for line fluctuation from 105-125 volts and less than 0.2 volts for load variation from 0 to maximum current.

RIPPLE: Less than 3 mv. rms.

STABILITY: The output voltage variation is less than the regulation specification for a period of 8 hours.

RECOVERY TIME: Less than 50 microseconds. The excursion in the output voltage during the recovery period is less than the regulation specification.

OUTPUT IMPEDANCE: Less than 0.1 ohms from 20 cycles to 100KC. Less than 0.5 ohms from DC to 20 cycles. Many units have very much lower output impedance.



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FEATURES:

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- Wire Harness and Resistor Board Construction.
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Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR16	0-150	Each supply	19″	12¼″	17″	$625
KR17	100-200	has two	19″	12¼″	17″	$625
KR18	195-325	15 Amp.	19″	12¼″	17″	$695
KR19	295-450	outputs	19″	12¼″	17″	$695

600 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 8	0-150	Each supply	19″	10½″	13″	$330
KR 5	100-200	has two	19″	10½″	13″	$240
KR 6	195-325	10 Amp.	19″	10½″	13″	$240
KR 7	295-450	outputs	19″	10½″	13″	$250

300 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 12	0-150	Each supply	19″	7″	11″	$270
KR 3	100-200	has two	19″	7″	11″	$180
KR 4	195-325	5 Amp.	19″	7″	11″	$180
KR 10	295-450	outputs	19″	7″	11″	$190

125 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 11	0-150	Each supply	19″	7″	11″	$180
KR 1	100-200	has one	19″	7″	7½″	$ 90
KR 2	195-325	3 Amp.	19″	7″	7½″	$ 90
KR 9	295-450	output	19″	7″	7½″	$ 97

To include 3″ Current and Voltage Meters, Add M to Model number (e.g. KR 16-M) and Add $30.00 to the Price.
To include Dust Cover and Handles for Table Mounting, Add C to Model number (e.g. KR16-C) and Add $10.00 to the Price.
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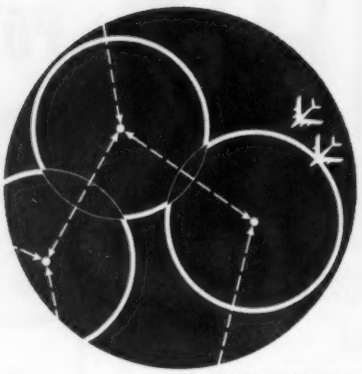

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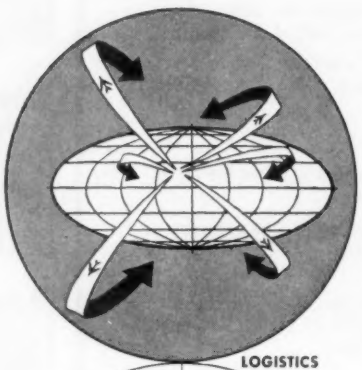
NEW HORIZONS IN **DATA PROCESSING**

Hughes digital data processing systems are being used in the solution of one of our nation's most vital problems—defense against air attacks. In this age of atomic weapons and high-speed, high-altitude bombers, defense systems had to be developed which would supply anti-aircraft weapons with data on the position, speed, and direction of enemy planes. Hughes data processing systems surpass the most stringent requirements of modern anti-aircraft defense. Data may be received from many sources simultaneously; complex computing functions are carried out automatically; and data distribution is nearly instantaneous.

In the Hughes anti-aircraft defense systems, target information is received from radar stations. The system then accomplishes detection, identification, and tracking of enemy targets; storage and evaluation of the target data; and distribution of target and weapons assignment data to the anti-aircraft batteries. The batteries are thereby effectively coordinated in repelling the enemy attack. By linking together a number of such systems for the exchange of tactical information, a tight defense perimeter can be formed against aerial attack from any direction.

The contributions of the Ground Systems Laboratory have helped to make Hughes the West's leading center for advanced electronics. Hughes offers its Engineers and Scientists excellent salaries, constant challenge, and the luxury of Southern California living. For further information concerning the great opportunities at Hughes write us at the address below.



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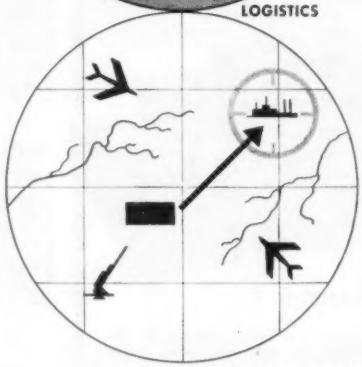

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experienced in the equipment design of digital computers. These engineers should be capable of working with schematic diagrams to design complete equipment packages. Knowledge of etched circuit design techniques is desirable.

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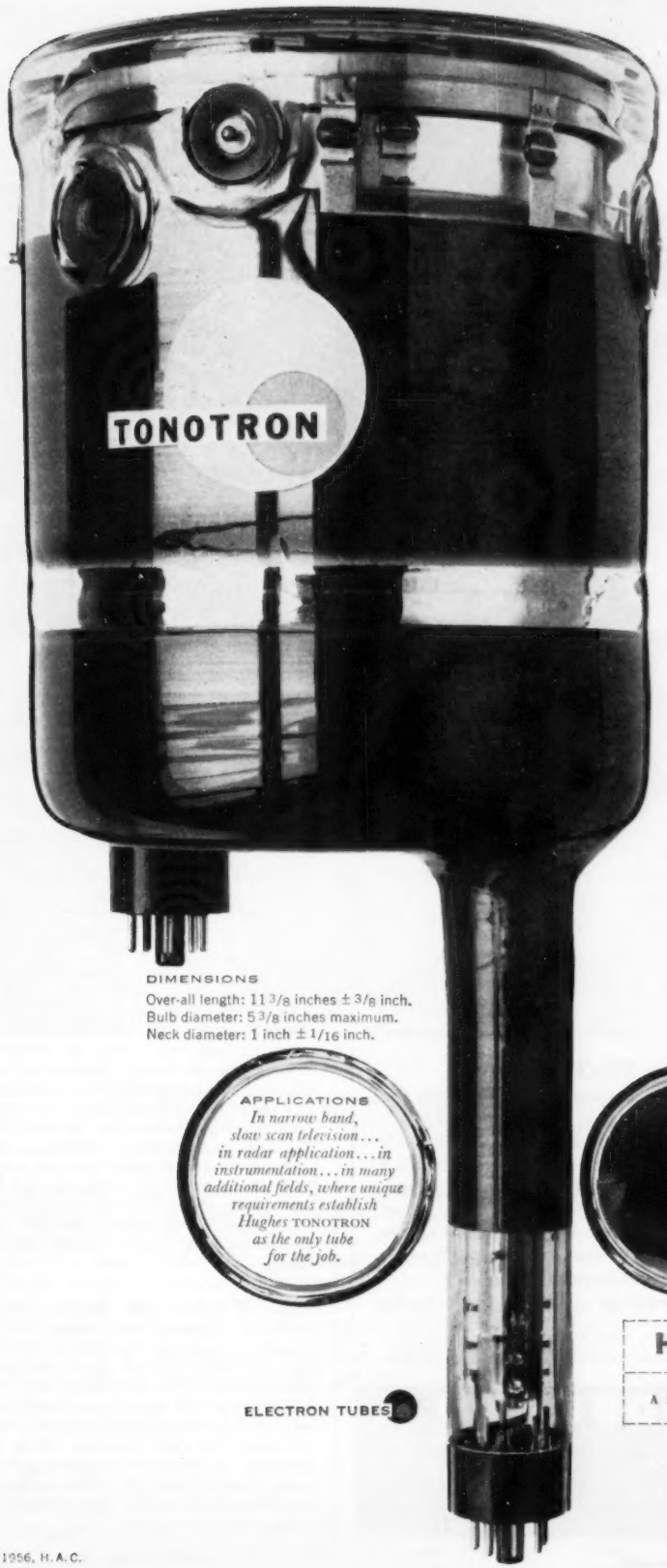
to select, evaluate or develop specialized components such as transformers, delay lines, capacitors, etc.

DATA SYSTEMS ENGINEER

to work on digital data processing in the area of storage memories and computer-type processing circuits.

MICROWAVE ENGINEER

for work on large high-gain antennas and transmission lines.



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Over-all length: 11 3/8 inches ± 3/8 inch.
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In narrow band, slow scan television... in radar application... in instrumentation... in many additional fields, where unique requirements establish Hughes TONOTRON *as the only tube for the job.*

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For more information circle 12 on reader service card.

BIDDLE *Instrument News*

FRAHM® FREQUENCY MONITOR

. . . for opening or closing an electrical contact when the frequency of the power line to which the monitor is connected reaches a preset limit. The monitor can be furnished for low or for high limit operation.

TYPICAL APPLICATIONS

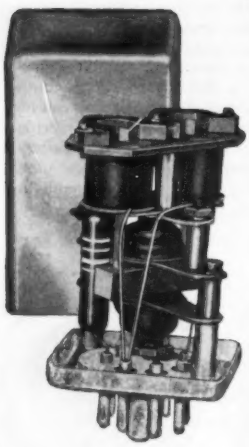
. . . In power transmission systems as a low frequency alarm with manual reset to call for load shedding or other corrective action to bring system frequency back to normal.

. . . For generators as low and high frequency alarm and, under certain conditions, as simple "on-off" frequency controller which can keep frequency between preset low and high limit.

. . . For turbines and other machinery with parts rotating at high speed as overspeed alarm and limiter when used in conjunction with an electric tachometer generator.

Write for **PRICES** and **BULLETIN 33-06-EE**

FRAHM® RESONANT REED OSCILLATOR CONTROLS



These electro-mechanical components are used in electronic oscillator circuits to stabilize the oscillation frequency within close limits.

Oscillator controls can be made for any frequency within the range of 50 to 1100 cps.

TYPICAL APPLICATIONS

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FEATURES

High accuracy and stability of oscillating frequency • Self starting operation • Full interchangeability of oscillator controls with different nominal frequency in the preferred circuits • Infinite operating life of the reeds • Integral unit sealed, magnetically shielded and of very rugged construction • Light weight and small • Can be furnished to meet certain military specifications for electronic circuit components.

Write for **PRICES** and **BULLETIN 34-EE**

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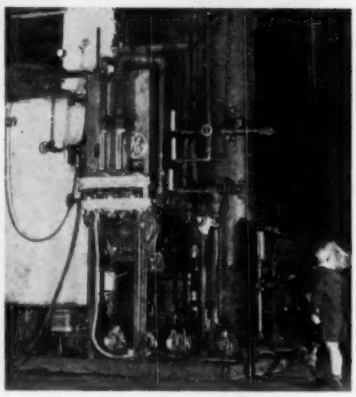
Industrial Notes

(*Continued from page 14A*)

for special applications and high alloy steels. Equally important, this process will increase the array of available metals and alloys that have superior mechanical and chemical properties and offer high corrosion resistance, great strength at elevated temperatures, and improve workability. In the final processing of metals, vacuum

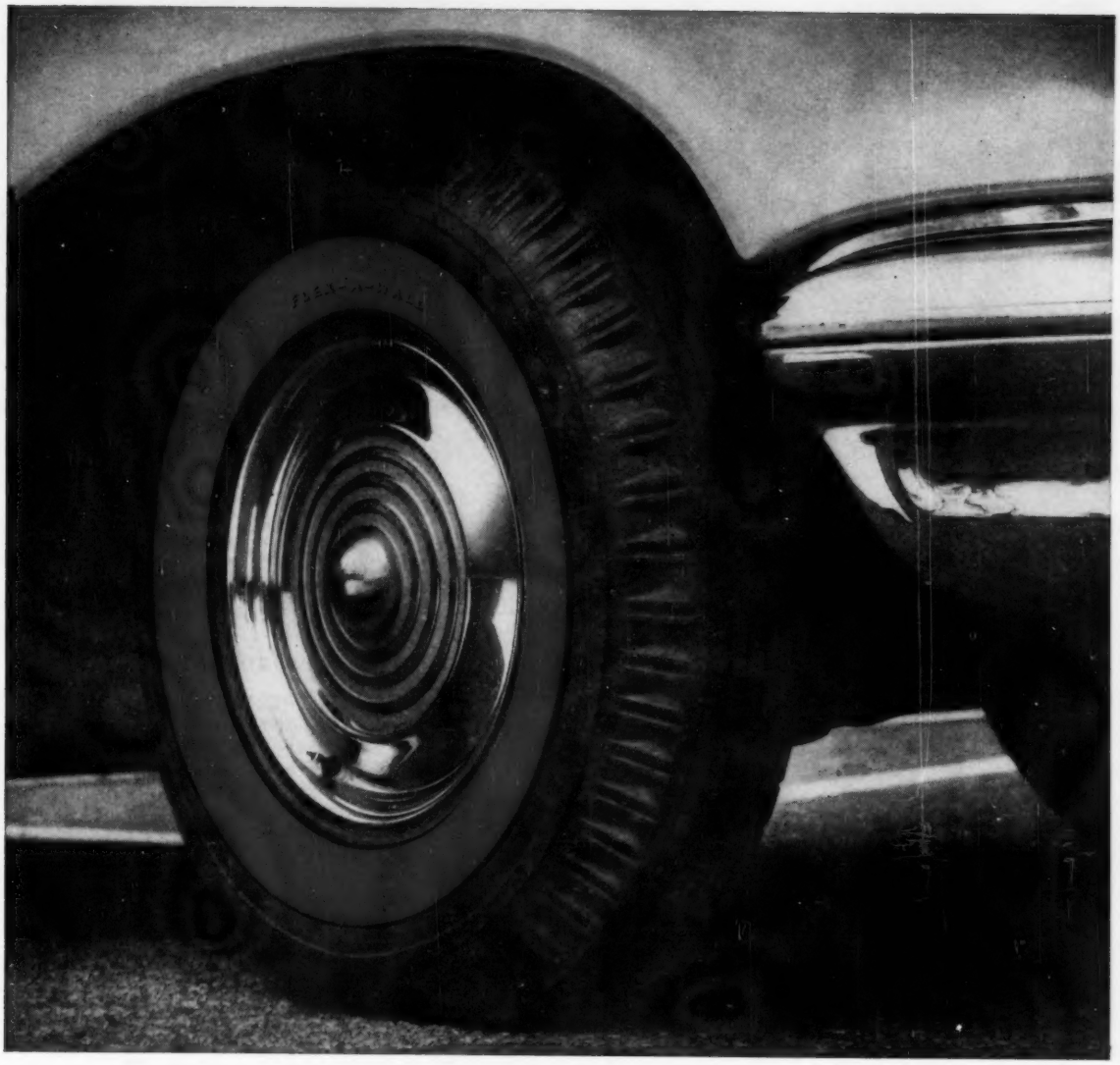


Courtesy General Electric

heat treatment will permit more exacting control as well as improve their workability and service life. In the field of brazing, the use of protective atmosphere gases and vacuums will simplify, and in many cases provide the only method, for joining metals and ceramic—metals for higher temperature use. Now in use are systems for centralized protective atmosphere production, to provide atmosphere gases for use in different locations throughout a plant. There will be a corresponding development of furnace equipments which will provide faster heat-up, higher temperatures, continuous operation, with completely automatic, more precise control. The new $5 million plant, under construction since early 1955 and completed recently, consolidates all of the industrial heating manufacturing facilities of the company at Shelbyville. One of the most striking features of the plant is a unique floor level conveyor system, believed to be the strongest of its kind in existence. It is designed to accommodate furnaces weighing up to 60 tons. Consisting of steel flat cars drawn by underground drag chains, the system makes possible assembly line production techniques on custom designed furnaces.

Research Laboratories Expand. Cook Research Laboratories, Skokie, Ill., a Division of Cook Electric Company of Chicago, will occupy a new plant now under construction in Morton Grove, Ill. The new structure will provide additional space of 31,000 square feet and will be utilized principally for radar research. With this addition, the laboratory facilities will occupy a total of 140,000 square feet which includes aircraft hangar space at Vandalia, Ohio.

(*Continued on page 22A*)



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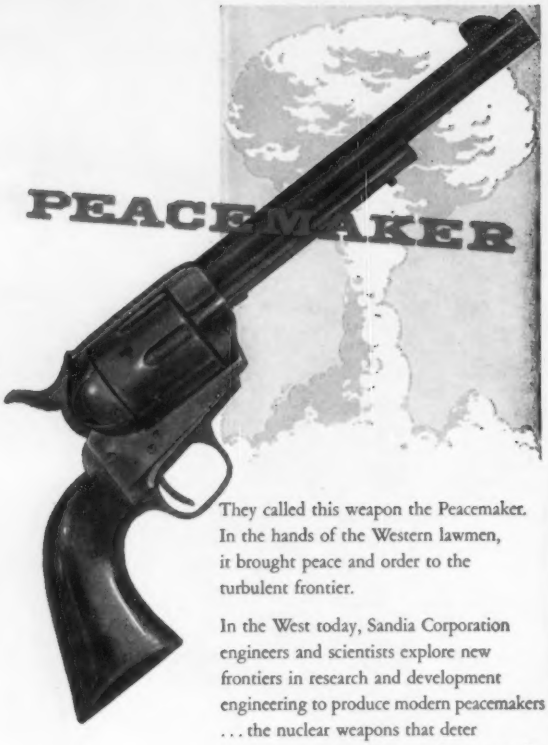

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Sandia Corporation, a subsidiary of the Western Electric Company, operates Sandia Laboratory in Albuquerque, N. M. and a branch installation at Livermore, Cal. under direct contract with the Atomic Energy Commission. At both of these locations, engineers and scientists who look to the future find challenge and opportunity . . . the challenge of advanced problems in a broad range of research and development activities, and the opportunity for professional growth and individual advancement in a stimulating new field. In addition, they enjoy excellent living and working conditions, and outstanding employee benefits.

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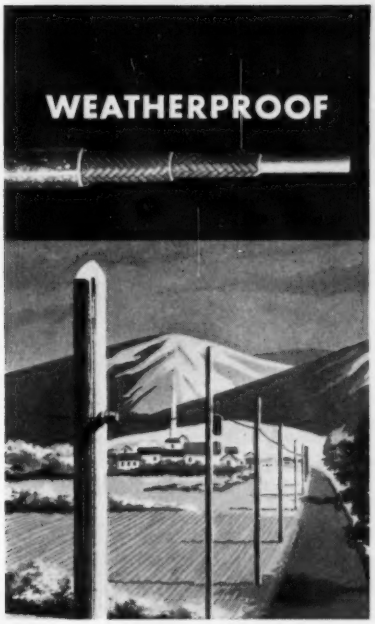

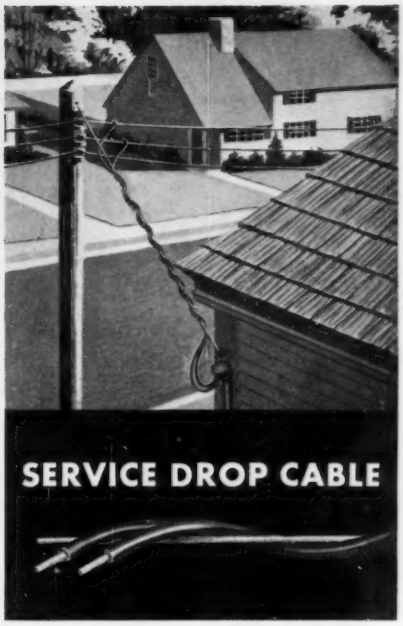

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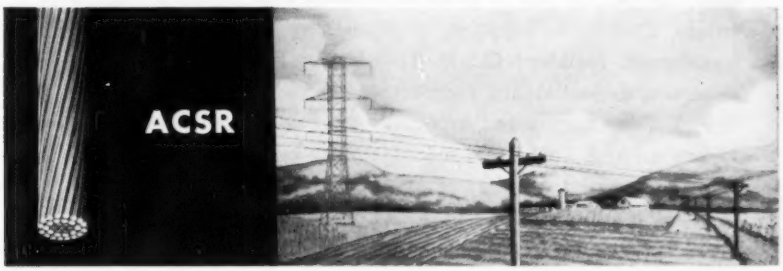
FOR ALL ALUMINUM CONDUCTOR REQUIREMENTS



Built into all ALECTRAL products are 75 years of General Cable's engineering and manufacturing experience. In this record are more than 25 years of successful performance of *insulated* aluminum conductors marketed as ALECTRAL. Available in ALL-ALUMINUM, ACSR, WEATHERPROOF and with RUBBER and THERMOPLASTIC insulations. A sound and economical investment for all voltage ranges.

GENERAL CABLE CORPORATION, 420 Lexington Avenue, New York 17, N. Y.
Offices and Distribution Centers Coast-to-Coast

For quality and service...SPECIFY GENERAL CABLE

For more information circle 16 on reader service card.

built SPECIALLY for the *original equipment manufacturer

Each component part of **your** equipment must function without failure. One of the most important of these integral parts is the transformer. Standard O.E.M. Transformers are noted for their accuracy, dependability, compactness and sound basic construction. They're engineered especially for O.E.M. use. Many well-known original equipment manufacturers have specified O.E.M. Transformers for over 30 years. You can have Standard O.E.M. Transformers tagged for you, too! Consult your nearby Standard representative or write to Standard direct for specific information, literature or engineering consultation.

Standard
THE STANDARD TRANSFORMER COMPANY
Trade Mark ®

WARREN, OHIO
REPRESENTATIVES IN PRINCIPAL CITIES

▲ Circle 17 on the card.

(*Continued from page 18A*)

NEW PRODUCTS

Compression Sleeves. Service entrance compression sleeves made by Anderson Electric are made of a highly conductive aluminum alloy with 5/8-inch OD and designed to make use of existing 5/8-inch dies and tools which are currently available. The 5/8-inch line consists of 17 sizes to accommodate all popular combinations of aluminum, steel-reinforced aluminum cable and copper conductors from No. 8 American Wire Gauge to 1/10 AWG. Sleeves are marked to show the die size, die press area, catalogue number, and complete cable size application. Fade-proof standard color coded plastic caps are used to identify quickly the cable sizes of each groove. These caps are easily punctured so the cable can be pushed through the caps without removing them. A stop is provided in the center of the compression sleeve to prevent dissimilar cables from contacting each other. The sleeves are factory filled with a special inhibitor for high conductivity, high pull-out strength, and compatibility with copper, aluminum, or combinations of each.

▲ Item 18 on the card.

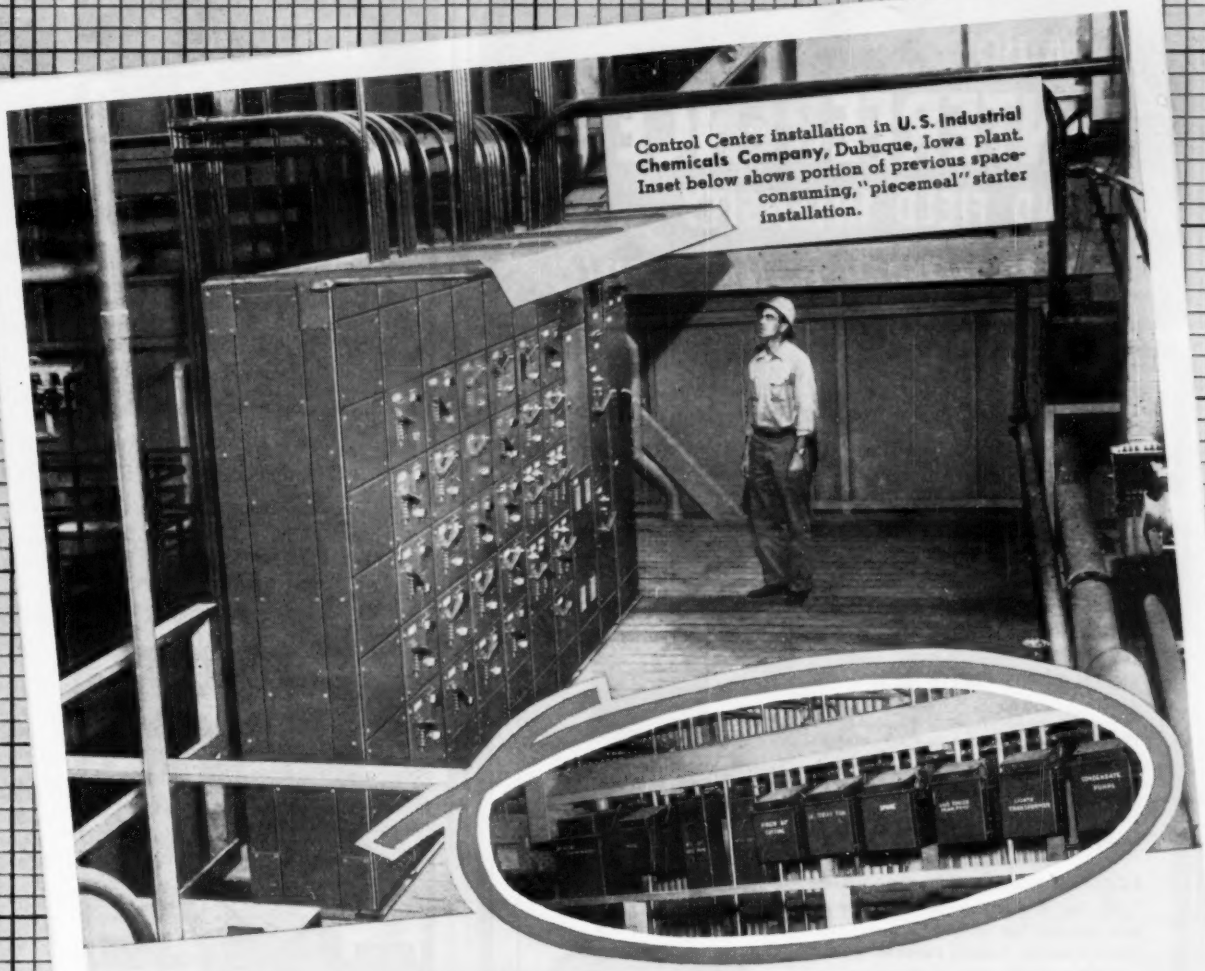
Junction Transistor Checker. A simple and accurate junction transistor checker has been announced by Instant Circuits Division of Alfred W. Barber Laboratories. This Checker measures the significant characteristics of *p-n-p* or *n-p-n* transistors; namely, collector leakage with base grounded, collector current at zero base current (base open), and base to collector current gain at 4.5 volts on the collector. Self-contained, with batteries lasting over a year in normal use, the Checker is quick and easy to use and needs no warm-up time. The meter reads gain directly, showing up defective units and indicating relative gain. A novel and very useful feature is the provision of pin jacks connected to base emitter and collector circuits for plugging in clip leads. A comprehensive instruction book is included with each.

▲ Item 19 on the card.

Slotted Line and Broadband Probe. A coaxial slotted line, and a broadband probe are included in the Press Wireless Laboratories microwave test equipment and accessories now distributed in the United States and Canada by Vectron, Inc. The precision coaxial slotted line, Model *SL-42*, is used in the design and testing of coaxial line components to provide a means of making accurate voltage standing wave ratio (VSWR) and impedance measurements in the S, C, and X band regions, to assist in eliminating transmission line mismatches, and to determine antenna reflection characteristics. The completely tunable, Model *PR-25*,

(*Continued on page 26A*)

Circle 20 on the card. ▶



Control Center installation in **U. S. Industrial Chemicals Company**, Dubuque, Iowa plant. Inset below shows portion of previous space-consuming, "piecemeal" starter installation.

"COMPARISON convinced us that a SQUARE D Control Center offered us MORE!"

These design features make Square D your logical choice, too . . .

INCREASED SAFETY because bus bars are fully enclosed, rigidly supported and have ample cross section. Circuits are isolated by individually enclosed plug-in units. Disconnect handle designed for maximum operator protection.

FLEXIBILITY. Individual plug-in units or complete sections are easily added, removed or exchanged. Pushbuttons, pilot lights, and selector switches are readily added to unit doors.

INSTALLATION ECONOMY. All wiring channels are large and accessible from front without removing units. No "wire fishing."

SPACE ECONOMY, TOO. Up to six combination starters fit in a 20" x 20" x 90" section. Plug-in unit heights designed in space-saving increments of 3 inches.

NOW...EC&M PRODUCTS ARE A PART OF THE SQUARE D LINE!

SQUARE D COMPANY

RADIO INTERFERENCE AND FIELD INTENSITY *measuring equipment*

Stoddart equipments are suitable for making interference measurements to one or more of the following specifications:

Air Force – MIL-I-6181B
150 kc to 1000 mc
BuAer – MIL-I-6181B
150 kc to 1000 mc
BuShips – MIL-I-16910A (Ships)
14 kc to 1000 mc
SIGNAL CORPS – MIL-I-11683A
150 kc to 1000 mc
SIGNAL CORPS – MIL-S-10379A
150 kc to 1000 mc

The equipments shown cover the frequency range of 14 kilocycles to 1000 megacycles.

Measurements may be made with peak, quasi-peak and average (field intensity) detector functions.

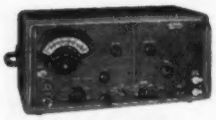
F.C.C. PART 15 – Now in effect, the revised F.C.C. Part 15 places stringent requirements upon radiation from incidental and restricted radiation devices. Stoddart equipment is suitable for measuring the radiation from any device capable of generating interference or c-w signal within the frequency range of 14 kc to 1000 mc.

Write Stoddart Aircraft Radio Co., Inc., for your free copy of the new revised F.C.C. Part 15.

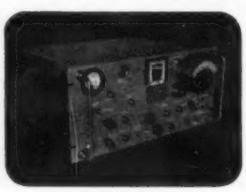
NM-10A (AN/URM-6B)
14 kcs to 250 kcs

NM-20B (AN/PRM-1A)
150 kcs to 25 mcs

NM-30A (AN/URM-47)
20 mcs to 400 mcs



NM-50A (AN/URM-17)
375 mcs to 1000 mcs



The **Stoddart NM-40A** is an entirely new radio interference-field intensity measuring equipment. It is the commercial equivalent of the Navy type AN/URM-41 and is tunable over the audio and radio frequency range of **30 CPS to 15 kc.** It performs vital functions never before available in a tunable equipment covering this frequency range. Electric and magnetic fields may be measured independently over this range using newly developed pick-up devices. Measurements can be made with a 3 db bandwidth variable from 10 CPS to 60 CPS and with a 15 kc wide broadband characteristic.

STODDART *Aircraft Radio Co., Inc.*
6644-B SANTA MONICA BLVD., HOLLYWOOD 38, CALIFORNIA · Hollywood 4-9294

VISIT OUR BOOTH 111, WESCON SHOW
▲ Circle 21 on the card.

HOT DIP GALVANIZING

. . . FOR EVERY REQUIREMENT IN THE ELECTRICAL FIELD

Our Record: Over 50 years of progressive galvanizing service to manufacturers and fabricators of iron and steel products . . . any size or shape, any size order from the smallest to the largest. *Excellent facilities for pickling and oiling.*

"TO ECONOMIZE, GALVANIZE AT ENTERPRISE"

ENTERPRISE GALVANIZING CO.
2521 E. CUMBERLAND STREET
PHILADELPHIA 25, PENNSYLVANIA

▲ Circle 22 **▼ Circle 23**

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CABLE
POWERS
the
MUSCLES
of
INDUSTRY
CERTIFIED
WRITE for the complete story of BRONCO 66 CERTIFIED, the dependable, extra flexible, electrical cables through which energy flows to the power tools of industry. These Synchro-Cured portable electrical cords and cables are made with a branded jacket certified to contain not less than 67.32% Neoprene.
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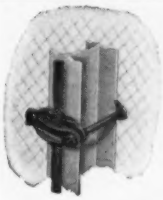
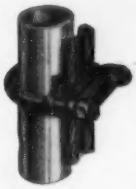
WESTERN INSULATED WIRE CO., Los Angeles 58, California
ASK YOUR ELECTRICAL WHOLESALE DISTRIBUTOR FOR THE CABLE WITH THE 68% NEOPRENE JACKET



TYPE GA-H—CABLE TO H-BEAM FENCE POST—*This grounding connector joins wide range of standard H-beam posts to fence fabric and cable. Range of cables easily accommodated. Sizes available for grounding more than one cable. One-wrench installation.*



TYPE GD—2 CABLES TO PIPE *Clamp-type ground connector for joining range of two equal cables or single looped cable to pipe or column. Especially convenient for grounding fence posts. Wide range of sizes.*

TYPE GX—CROSSED WIRES OR CABLES—*Simple, rapid connection, easy to inspect. Recommended for crossing ground conductors in order to secure greatest efficiency in reducing voltage gradient. Connector takes wide range of sizes.*

TYPE GB—CABLE TO FLAT SURFACE *Connects wide range of ground lead cable to flat structural or equipment surfaces. Can be furnished with larger than standard size bolts for pre-punched holes in steel work. One-wrench installation.*

TYPE GP—2 PARALLEL CABLES 90° TO GROUND ROD—*Clamp-type connector joins two parallel cables at right angle to ground rod, pipe, or column. Accommodates range of cable sizes in each groove.*

TYPE GAR—CABLE TO ROD OR PIPE...PARALLEL OR 90° *Double-purpose ground connector—joins ground bus to rod or pipe either parallel or at right angles. Easily installed by tightening two nuts on U-bolt. Accommodates wide range of cable.*

TYPE GK—3 EQUAL CABLES TO GROUND ROD OR PIPE—*This connector is frequently used to join grounding conductor, grounded member, and looped ground bus, at one point. Accommodates wide range.*

TYPE GG—BRAID, BAR, LEAF, OR CABLE TO PIPE—*Joins flat flexible braid or copper bar to ground pipes, fence posts, and columns. Highly effective for grounding operating rods, switch handles, gate posts. Can be used with stranded cable by splaying ends under clamp.*

TYPE YA (HYLUG)—GROUND CABLE TO FLAT BAR—*Compression connector—one-piece terminal, easily and economically installed with Burndy portable Hypress. Available for #8 str. to 1000 Mcm.*

9 sound solutions to the problem of

GROUNDING

Engineered to the same precise standards as connectors that carry continuous current loads . . . Burndy grounding connectors can be depended on to provide permanent protection against

• ARC-OVERS • ELECTRICAL LEAKAGE
• LIGHTNING • DIRECT SHORT CIRCUITS

These nine designs are available in 30 variations for connection to driven rod, pipe, cable, fence post, structures, lamp standards.

Send for the Burndy Grounding Catalog, which offers an interesting technical discussion on approved techniques, methods, and materials for proper grounding.

BURNDY

NORWALK, CONNECT. — TORONTO, CANADA • *Factories:* NEW YORK, CALIF., TORONTO • *Export:* PHILIPS EXPORT COMPANY

For more information circle 24 on reader service card.

MONEY IN THE BANK...
A financial giant, the new Texas National Bank rises on the fabulous Texas Gulf coast. Marcus transformers provide "money in the bank" dependability for power and lighting distribution. For trouble-free performance and greater profits, choose Marcus for your next transformer installation
Architect: Kenneth Franzheim, Consulting Engineers: Bernard Johnson & Associates, Electrical Contractor: Howard P. Foley Co.
MARCUS
TRANSFORMER CO., Inc.
RAHWAY, NEW JERSEY
Representatives in Principal Cities
"Mark of Quality"
A COMPLETE LINE OF DRY TYPE AND LIQUID-FILLED TRANSFORMERS THRU 5000 KVA

▲ Circle 25 on the card. ▼ Circle 26.

easy to read . . .

THE MOSELEY **DC VOLTMETER** MODEL 20

A high accuracy, multi-range, servo actuated DC voltmeter with large linear scale. Eleven ranges from 3 millivolts to 300 volts, full scale. Available also with digitized output for direct connection to printer or other digital apparatus.

a servo voltmeter, easy to read, fast — adapted to data translation

We'll be glad to furnish additional information. Write:

F. L. MOSELEY CO.
409 N. FAIR OAKS AVE.
PASADENA, CALIFORNIA

New Products

(Continued from page 22A)

broadband probe greatly facilitates precision measurements over a broad frequency span. With its normal range, including L, S, C, and X bands, this probe can be used for the majority of slotted line and wave guide measurements required in the microwave laboratory. It has a 0.750-inch diameter mounting barrel and is suitable for use with most types of slotted lines.

▲ Item 27 on the card.

Control Panel Conduit. A control panel conduit featuring an exclusive slot design which reduces wiring time to an absolute minimum, has been developed recently. Known as the Panduit plastic wiring duct, it is now available in a wide range of sizes. The slot design introduces a considerably simplified method of inserting and removing wires in that the wires are merely snapped in and out of the duct. It also permits the attachment of lugs before the wire is inserted and allows the wire to be removed with lugs attached. The Panduit fastener also is a new introduction and holds both duct and cover thus preventing either from slipping.

▲ Item 28 on the card.

Minature Connector. A minature electric connector known as the "Pygmy" has been developed by Scintilla Division of Bendix Aviation Corporation, especially for application to miniaturized electronic equipment. The "Pygmy" will be available in both the A and E styles, in a series

for potting, with jam nut receptacles, and with hermetically sealed receptacles. Both a double stub quick action thread and a 3-point bayonet lock will be offered for the convenience of users. Either cadmium plate or alumilite finishes will be available for these connectors. Resilient Scinflex inserts will be used to resist vibration effects. The standard size *20* gold-plated contacts are the closed-entry type and will not accept oversize probes or pins. Full tooling is being provided for this entire line of connectors.

▲ Item 29 on the card.

(Continued on page 34A)

After clamp is dipped in oil carrying magnetic particles, it is magnetized in Magnaflux coil.

When inspected under "black light", any defects have plainly visible fluorescence.

TO SEE THE INVISIBLE

We Use "BLACK LIGHT" to Inspect Hi-Lite Strain Clamps

An important goal of O-B's inspection program is to make sure every Hi-Lite Strain Clamp which you receive will perform within rated strengths. To assure freedom from defects that might impair strength, we use a series of inspection safeguards.

Defects that can be seen are no problem. We catch them on visual inspection checks and by routine checking during manufacture. But what about defects that aren't visible?

To see the invisible, we examine Hi-Lite Clamps under the "black light" — the ultraviolet rays that are part of the Magnaflux-Magnaglo inspection method. Each clamp is dipped in an oil carrying magnetic particles, magnetized and then checked with the "black light." Under "black light", even the smallest defect glows and is plainly visible to the inspector.

But Magnaflux is more than an inspection tool. It's also a method of quality control. We're not content just to find defects. That's just the starting point. We then seek out the causes and eliminate them.

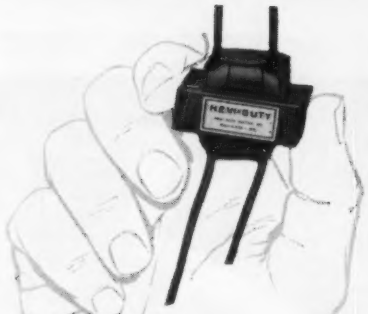
Actually, we find few defects. But according to our reasoning, even one flaw would be too many, if it weren't detected. Magnafluxing of every Hi-Lite Clamp is another good example of Technical Competence in action, working to deliver a completely reliable product.

OHIO BRASS COMPANY • MANSFIELD, OHIO

TECHNICAL COMPETENCE THE HEART OF ALL Ohio Brass HARDWARE

4676-H

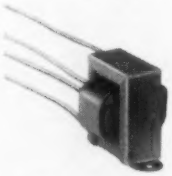
For more information circle 30 on reader service card.



WHEREVER
Quality
COUNTS

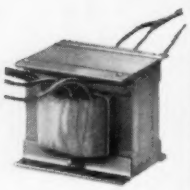
you're wise to specify
HEVI-DUTY transformers

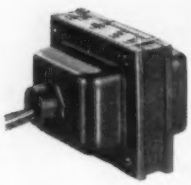
You can be sure of dependable operation of electrical components when you use Hevi-Duty transformers.



Coils are precision-wound with high-dielectric insulating materials between layers.

Every Hevi-Duty transformer is impregnated with a polymerizing-type varnish that resists moisture and corrosion.





All Hevi-Duty units are built and tested to meet or exceed NEMA, ASA and AIEE standards. Terminals or poly-vinyl-insulated, color-coded leads are firmly anchored to coils.

Whether your plans call for 1 transformer or 1,000, Hevi-Duty offers complete facilities to assist in designing and building a transformer to meet your precise requirements. Send us your specifications, or write for
BULLETIN HD-499.

HEVI-DUTY®

HEVI-DUTY ELECTRIC COMPANY
MILWAUKEE 1, WISCONSIN
Heat Treating Furnaces . . . Electric Exclusively
Dry Type Transformers Constant Current Regulators

▲ Circle 31 on the card.

AIEE REPORTS

These publications are proposals for new standards or test codes, or revisions of present publications, which are in the formative stage. They are made available without cost, so that all interested individuals may obtain them for study and comment, thus supplying practical experience in their use before submission for adoption.

1A General Principles for Rating of Electric Apparatus for Short-Time Intermittent or Varying Duty (September 1941)

1C Test Code for Evaluation of Systems of Insulating Materials for Random-Wound Electric Machinery (January 1954)

1 Addendum to AIEE No. 1. General Principles Upon Which Temperature Limits Are Based in the Rating of Electric Machines and Other Equipment (February 1956)

28B Revised Report on Standards for Valve and Expulsion Type Lightning Arresters (March 1956)

52 Application Guide for Grounding of Instrument Transformer Secondary Circuits and Cases (March 1951)

53 Proposed Guide for Operation and Maintenance of Dry Type Transformers with Class B Insulation (October 1952)

56 Insulation Maintenance Guide for Large AC Rotating Machinery (May 1954)

57 Test Procedure for Evaluation of the Thermal Stability of Enamelled Wire (October 1955)

58 Induction Motor Letter Symbols (January 1956)

59 Test Code for Metallic Rectifiers (March 1956)

450 Guide for Specification of Electronic Voltmeters (April 1955)

451 Guide for Specification of Signal Sources (April 1955)

452 Guide for Specification of Cathode - Ray Instruments (April 1955)

504 Test Code for Carbon Brushes (October 1953)

505 Test Code for Power Factor Testing of Power Transformers (January 1955)

506 Test Code for Power Factor Testing of Distribution Transformers (October 1955)

802 Test Code for Direct-Current Carbon-Pile Voltage Regulators for Aircraft (April 1955)

954 Application Guides for: Ground-Fault Neutralizers; Grounding of Synchronous Generator Systems; and Neutral Grounding of Transmission Systems (October 1954)

955 Guide for Evaluating the Effect of Solar Radiation on Outdoor Metal-Clad Switchgear (October 1955)

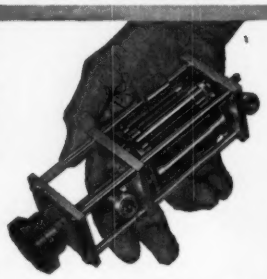
American Institute of Electrical Engineers
33 West 39th St., New York 18

PRECISION ATTENUATION to 3000 mc!

SINGLE *"in-the-line"*
ATTENUATOR PADS
and **50 ohm COAXIAL TERMINATIONS**

PROTECTED UNDER STODDART PATENTS

This new group of pads and terminations features the popular Types C and N connectors, and permits any conceivable combination of the two styles.



PROTECTED UNDER STODDART PATENTS

six-position
TURRET ATTENUATOR

- **Frequency Range:** dc to 3000 mc.
- **Characteristic Impedance:** 50 ohms.
- **Available Attenuation:** Any value from 1 db to 60 db.
- **Accuracy:** ±0.5 db.
- **Power Rating:** One watt sine wave power dissipation.

STODDART
Aircraft Radio Co., Inc.
6644-B SANTA MONICA BLVD.
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Why NATIONAL TRADE-MARK *brushes are best for*

CRANE AND HOIST MOTORS

Each Brush in the complete line of "National" brushes is compounded to meet a specific set of operating conditions. Together, these service-proved "National" brush grades provide a proper choice for every application in your mill or mine.

For Example, the following "National" brushes are recommended for crane and hoist service, as indicated. They are the finest brushes money can buy ... so much the best for these services that you will find they actually save you money in over-all cost of operation.

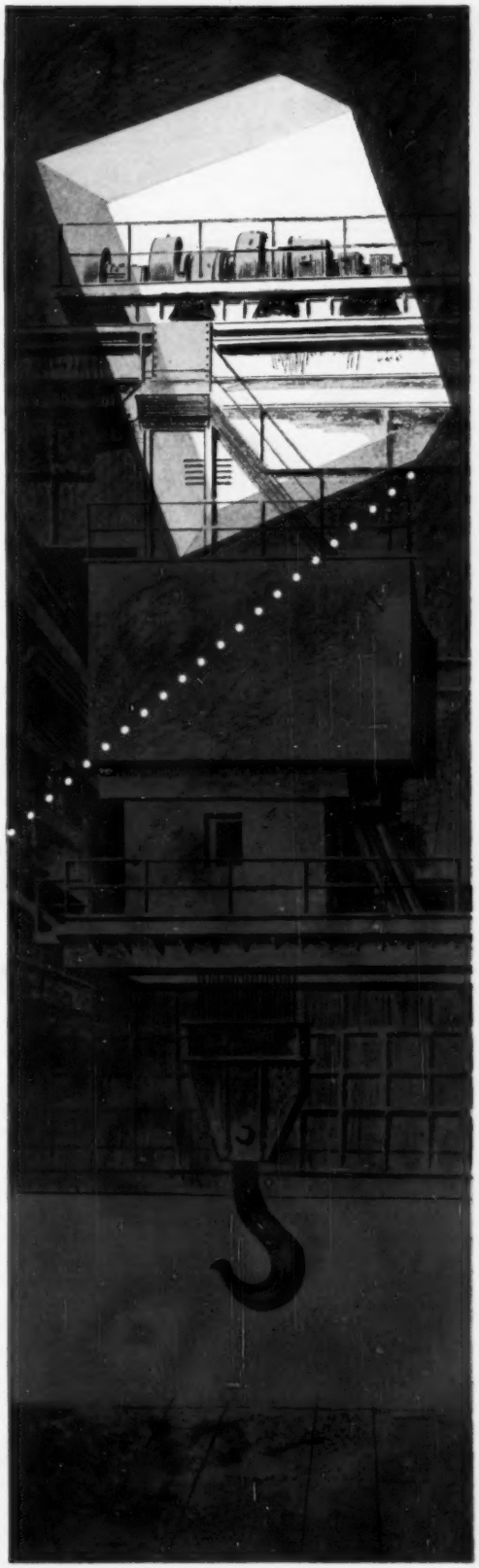
GRADES AX-5, TA-35, TA-45 and 401

These are standard grades with long service-records; application is in accordance with machine design.

GRADES 850 and N-4

Grade N-4 is highly efficient in handling alternate extremes of light and heavy loading; grade 850, for open-hearth ladle, soaking pit cranes and severe hoist conditions.

Be Certain of your brush selections. Get the recommendations of a "National" brush specialist to assure top performance and long life of costly equipment.



The term "National", the Three Pyramids Device and the Silver Colored Cable Strand are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY

A Division of Union Carbide and Carbon Corporation

30 East 42nd Street, New York 17, N.Y.

SALES OFFICES: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco

IN CANADA: Union Carbide Canada Limited, Toronto

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...New Opportunities...17 + Locations...One Best For You And Your Family

Can anyone but RCA offer you a choice of locations like this?
At Camden, Moorestown or Cherry Hill, you enjoy cultural advantages of Greater Philadelphia, live at moderate cost in pleasant suburban communities. Waltham offers at-home opportunities for New England engineers. Four ideal West Coast locations. Harrison borders on Greater New York. Lancaster, Marion and Findlay have small-town advantages. There's pleasant year-round outdoor living in Cocoa Beach, on Florida's central east coast. RCA Service Company and International Division assignments include ideal locations in the United States, and wherever RCA electronic equipments are installed and serviced throughout the world.

Individual Recognition—
RCA organizes engineering activities into groups small enough to allow broadest scope for your individual accomplishment. The average group has just 11 engineers. Yet, in all activities, you are supported by the entire facilities and engineering resources of RCA.

Salaries—
RCA engineering salaries average measurably higher than other companies' in the field. Intermediate engineers, $5000-$8500; senior engineers, $8500-$15,000; staff and supervisory salaries open.

Advancement—
Scheduled, objective appraisal of your work speeds promotion. Professional and financial progress is just as sure as your achievements make it.

Professional Status—
RCA bases world leadership in electronics on the abilities of exceptional men at every organizational level. Many have notable engineering and scientific reputations. You work in day-by-day association with men of this caliber.

Benefits—
There's a complete program at RCA. A very liberal Tuition Refund Plan. Company-paid life, sickness and accident, hospital-surgical insurance for you and your family. Modern retirement plan. Relocation expenses paid. Suggestion and patent awards.

Now, Pinpoint Your Future

...Here are the Opportunities!
...Here are the Locations!

FIELDS OF ENGINEERING ACTIVITY	MANAGERS	TYPE OF DEGREE AND YEARS OF EXPERIENCE PREFERRED											
		Electrical Engineers			Mechanical Engineers			Physical Science			Chemistry Ceramics Glass Technology Metallurgy		
		0-2	2-3	4-15	0-2	2-3	4-15	1-2	2-3	4-15	1-2	2-3	4-15
• *SYSTEMS* *(Integration of theory, equipments and environment to create and optimize major electronic concepts.)* — **AVIATION ELECTRONICS • CONTROLS**			W	W M			M		W	W M			
DIGITAL DATA HANDLING DEVICES	M C		M C	M C		C	C		C	C			
MISSILE ELECTRONICS • RADAR	M W		M W X	M W X		M W	M W		M W	M W			
INERTIAL NAVIGATION	W			W			W			W			
COMMUNICATIONS				C						C			
• *DESIGN • DEVELOPMENT* **KINESCOPES (B & W and COLOR), OSCILLOSCOPES**—Electron Optics—Instrumental Analysis—Solid States (Phosphors, High Temperature Phenomena, Photosensitive Materials and Glass to Metal Sealing)		L	L Y	L Y	L	L Y	L Y	L	L	L	L	L Y	L Y
RECEIVING TUBES—Tube Design—Test and Application Engineering—Chemical and Physical Development—Methods and Process Engineering—Advanced Development		H	H	H		H	H		H	H		H	H
SEMI-CONDUCTORS—Transistors—Semi-Conductor Devices—Materials		H	H	H	H	H	H	H	H	H	H	H	H
MICROWAVE TUBES—Tube Development and Manufacture (Traveling Wave—Backward Wave—Magnetron)	H		H	H		H	H		H	H		H	H
GAS, POWER AND PHOTO TUBES—Photosensitive Devices—Glass to Metal Sealing—UHF and VHF—Power		L	L	L	L	L	L	L	L	L	L	L	
AVIATION ELECTRONICS—Radar—Computers—Servo Mechanisms—Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Automation—Transistorization	W C	W C X	W C X	W C X	W C	W C X	W C X	W C X	W C X	W C X			
COMPUTERS—Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms—Programming		C	C X	M C X	C	C X	M C X	C	C	M C			
RADAR—Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control—Information Handling—Displays	M C	M C X	M C X	M C X	M C X	M C X	M C X	M C X	M C X	M C X			
COMMUNICATIONS — Specialized Military Systems — Microwave—Aviation—Audio—Propagation Studies		C	C	C		C	C	C	C	C			
MISSILE ELECTRONICS—Systems Planning and Design—Radar—Fire Control—Shock Problems—Servo Mechanisms	M	M X	M X	M X	M	M	M X	M	M X	M X			
COMPONENTS—Transformers—Coils—TV Deflection Yokes (Color or Monochrome)—Resistors—Ferrites (Material and Parts)		C	Z C	Z C	C	Z C	Z C	C	C	C		Z C	Z C
• *SYSTEMS APPLICATION* *(Evaluation and Planning—Design and Development—Modification—Specification)*													
MISSILE TEST INSTRUMENTATION (Data Acquisition and Processing) — Radar — Telemetry — Timing — Communications — Optics — Computers	F	F S.	F S	F S	F S	F S	F S	F S	F S	F S			
RADAR—Airborne—Surface—Shipboard—Sonar—Fire Control	F	F S	F S	F S	F S	F S	F S	F S	F S	F S			
COMMUNICATIONS — Radio — HF — VHF — UHF — Microwave — Telephone — Teletype — Telegraph Terminal Equipment — Wave Propagation	F	F S I	F S I	F S I	F S	F S	F S	F S	F S	F S			
• *MACHINE DESIGN* Mechanical and Electrical—Automatic or Semi-Automatic Machines		L	L		L	L H Y	C H Y		L	L			

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Please send resume of education and experience, with location preferred, to:

Mr. John R. Weld, Employment Manager
Dept. A-14H Radio Corporation of America
30 Rockefeller Plaza, New York 20, N.Y.

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TYPE	Plate Average Current MA	Plate Dissipation Watts	Plate Inverse Voltage	Filament Volts	Filament Amps
2-25A	50	15	25,000	6.3	3.0
2-50A	75	30	30,000	5.0	4.0
8020	100	60	40,000	5.0	6.5
2-150D	250	90	30,000	5.0	13.0
250R	250	150	60,000	5.0	10.5
253	350	100	15,000	5.0	10.0
2-240A	500	150	40,000	7.5	12.0
2-2000A	750	1200	75,000	10.0	25.0
2X3000F	3000	3000	25,000	7.5	51.0
*2X1000A	1250	1000	25,000	26.5	2.25

*For Clipper Diode Service only

If your specifications call for mercury vapor rectifier tubes, Eimac manufactures both half wave and full wave types.

Eimac's High Vacuum Rectifiers Handle Peak Inverse Voltages from 15,000 to 75,000 Volts

Used in standard rectifiers and special applications involving extreme ambient temperatures, high operating frequencies, high peak inverse voltages or production of high frequency transients, Eimac's broad line of high vacuum rectifiers and clipper diodes is the finest in the industry, both electronically and physically.

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The World's Largest Manufacturer of Transmitting Tubes

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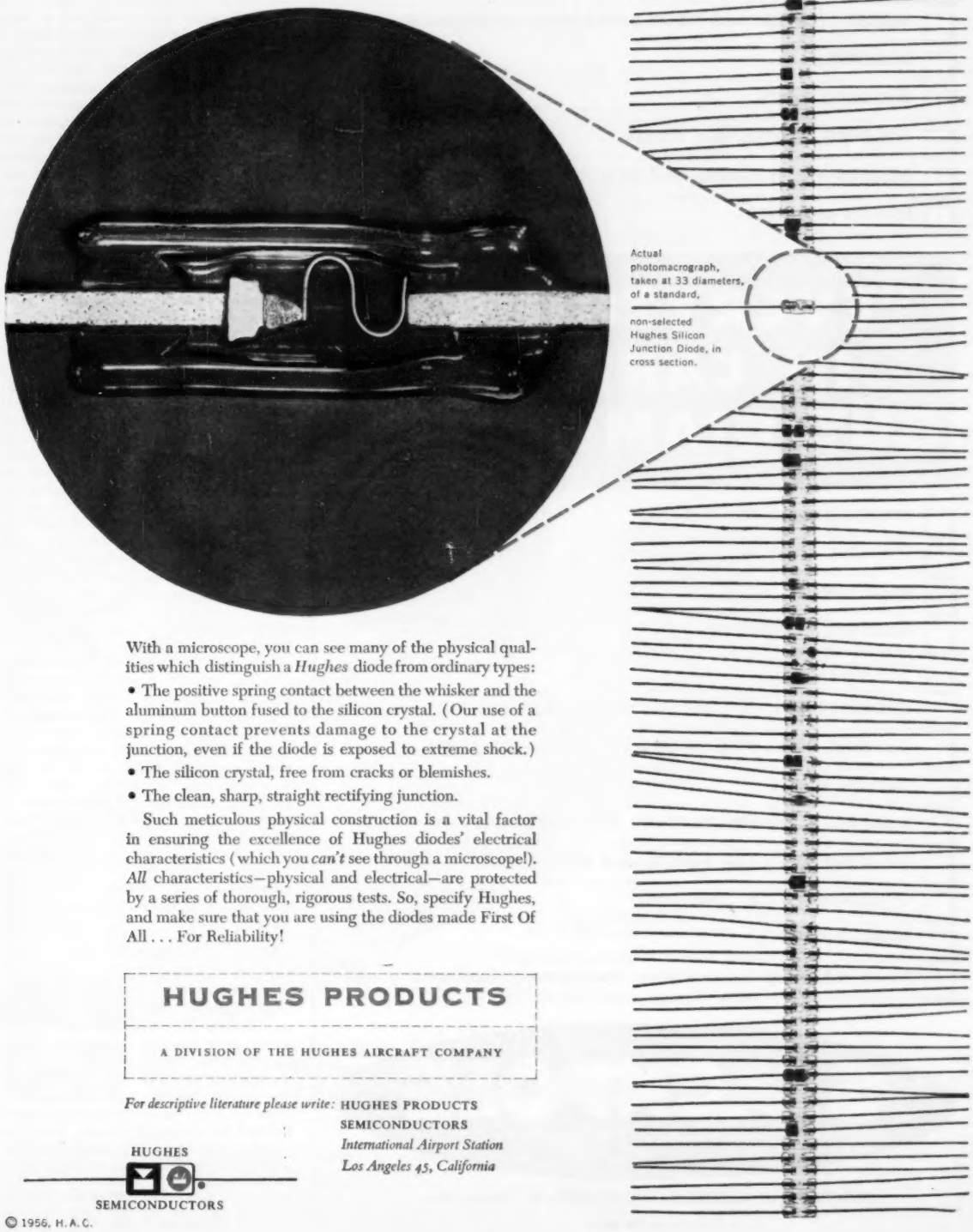
INSIDE, WHERE IT COUNTS, HUGHES DIODES LOOK LIKE THIS



Actual photomacrograph, taken at 33 diameters, of a standard, non-selected Hughes Silicon Junction Diode, in cross section.

With a microscope, you can see many of the physical qualities which distinguish a *Hughes* diode from ordinary types:

- The positive spring contact between the whisker and the aluminum button fused to the silicon crystal. (Our use of a spring contact prevents damage to the crystal at the junction, even if the diode is exposed to extreme shock.)
- The silicon crystal, free from cracks or blemishes.
- The clean, sharp, straight rectifying junction.

Such meticulous physical construction is a vital factor in ensuring the excellence of Hughes diodes' electrical characteristics (which you *can't* see through a microscope!). *All* characteristics—physical and electrical—are protected by a series of thorough, rigorous tests. So, specify Hughes, and make sure that you are using the diodes made First Of All . . . For Reliability!

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A DIVISION OF THE HUGHES AIRCRAFT COMPANY

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- **BRUSHES** for all rotating electrical equipment (Automotive-Aviation-Industrial-Traction, etc.)
- **GRAPHITE TUBE ANODES**
- **GROUNDING RODS** for protection against rust (earth and water types)
- **NON-WELDING ELECTRICAL CONTACTS**
- **VOLTAGE REGULATOR DISCS** (carbon piles)
- **WATER HEATER and PASTEURIZATION ELECTRODES**
- **BEARINGS**
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▲ Circle 36 on the card.

New Products

(*Continued from page 26A*)

Rotary Switch. Announcement of the development and availability of a rotary switch designated as Type *32-CM* has been made by the Daven Company. The new rotary switch is $1^{3}/_{4}$-inches in diameter by $1^{11}/_{16}$-inches in depth. It is available with three poles on a single deck and may be ordered with as many as 9 positions per pole with short circuit type action, or 5 positions per pole of non-short circuit type action. Solid silver alloy contacts, rotors, and slip rings are used throughout. The unit also employs the gold plated turret solder lug which provides excellent solderability and mechanical connection. Rotor and stator material is XXXP phenolic in accordance with MIL-P-3115B.

▲ Item 37 on the card.

Iso-Sonic Panels. These Sound-Dissipative translucent lighting panels for luminous ceilings have been introduced by ISO Industries, Inc., of Santa Monica, Calif. Utilizing the proved concepts of perforated surfaces for a high noise reduction coefficient, the Iso-Sonic panels are ideal for use in air-conditioned rooms where free circulation is required between upper ceiling chambers and room areas. Even when forced air circulation is not required, the electric lighting components enjoy prolonged life due to normal convection currents rising through the luminous ceiling. For maximum light diffusion and sound dissipation the perforated Iso-Sonic panels are used with Iso-Lyte (nonperforated clear plastic) panels inverted and spaced above the Iso-Sonic panels. Unlike other double layer panel installations, the 2-part ISO panels may be separated for thorough cleaning. All ISO panels have strong continuous aluminum edgings completely encircling each panel. The specially designed triangular cross section gives maximum strength and forms retention in all planes, assuring uniformity of size and flatness for the life of the panel. The aluminum edges will resist corrosion and prevent staining of panels following cleaning. Fabricated of specially formulated vinyl plastic, ISO panels have consistent whiteness, maximum light diffusion and transmission, and will not support combustion. A brochure is available upon request.

▲ Item 38 on the card.

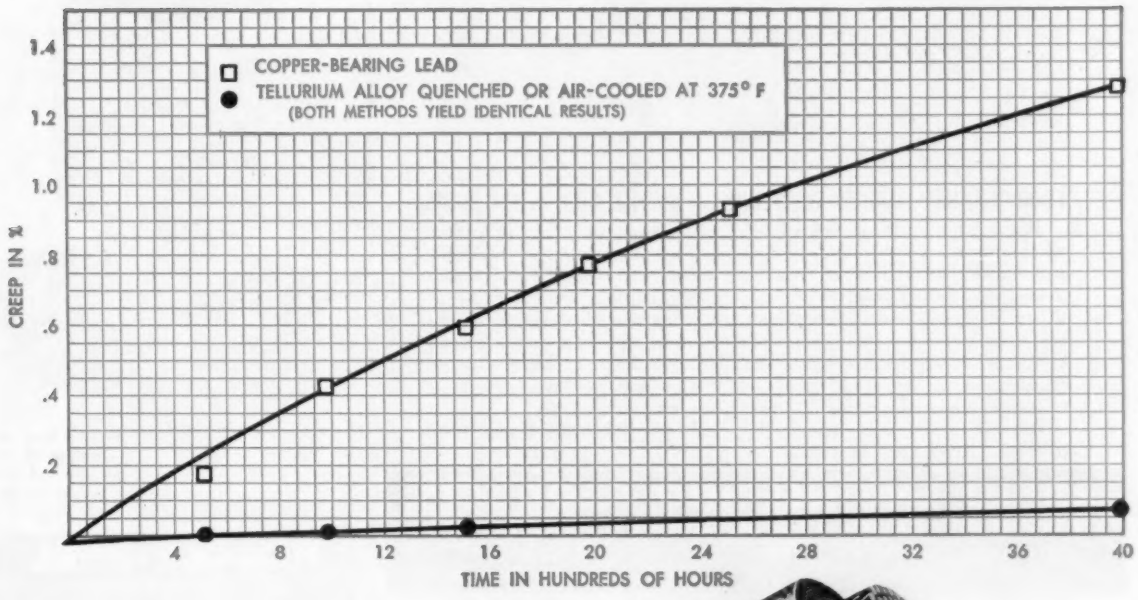
Glass Resistors. Precision film-type glass resistors are now available with greatly increased maximum resistance values. Corning Glass Works has announced that the range of its 1- and 2-watt, 1 per cent tolerance resistors has been increased by a factor of 10. These resistors are recommended for computer circuits, pulse networks, high frequency circuits, and low signal-level, high-gain amplifier stages.

▲ Item 39 on the card.

(*Continued on page 42A*)

ROEBLING PAPER POWER CABLE WITH TELLURIUM LEAD ALLOY SHEATH

CREEP OF TELLURIUM LEAD ALLOY AND OF COPPER-BEARING LEAD AT 200 PSI - 150° F



TELLURIUM LEAD ALLOY HAS ONLY **1/10** THE CREEP RATE OF COPPER-BEARING LEAD

THE ABOVE GRAPH illustrates one big reason why power cable with Roebling tellurium lead alloy sheath is vastly more dependable and long-lived than cable with ordinary lead sheathing. But besides its low long-time creep rate, tellurium lead alloy has every other characteristic essential for meeting today's load and temperature requirements... extra fatigue resistance... high bursting strength... *top stability under heat.* Write for full facts about this new development—the most important sheath improvement in years.

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FOUR-CHANNEL CARRIER-TELEPHONE TERMINAL FOR RADIO LINKS

This is a miniaturized unit of advanced design which provides four voice channels on a frequency-division basis above a voice-frequency order-wire channel. Each of these five channels is provided with a 4-wire 2-wire termination and a voice-frequency ringing circuit for d-c or 20-cycle signals. Adjustable attenuators are provided in the 4-wire side of all channels, and a built-in test oscillator and meter permit complete line-up, maintenance and trouble-shooting checks to be made. Channel levels are from −9 to 0 dbm and line levels from −30 to 0 dbm. Channel width is 300 to 3500 cycles within 1 db.

This unit is only 5¼″ high by 19″ wide by 14″ deep. It mounts on a standard rack and operates from 115 volts 50-60 cycles a.c.

RADIO ENGINEERING PRODUCTS
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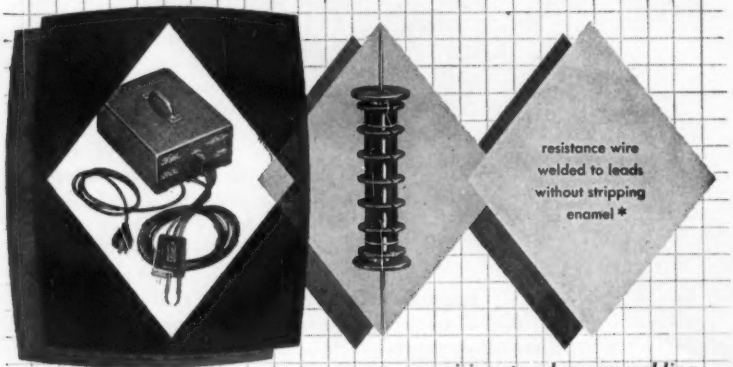
▲ Circle 41 on the card. ▼ Circle 42.

TERMINATE PRECISION RESISTORS WITH SPEED AND RELIABILITY



precision stored-energy welding

WELDMATIC MODEL 1012 TWEEZER TYPE WELDER welds fine wire to leads or tabs while resistor is on winder. Enamel stripping and flux contamination eliminated, with production time halved. Welded connection is very positive, stable, and rugged.

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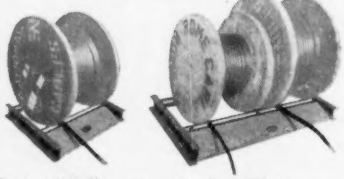

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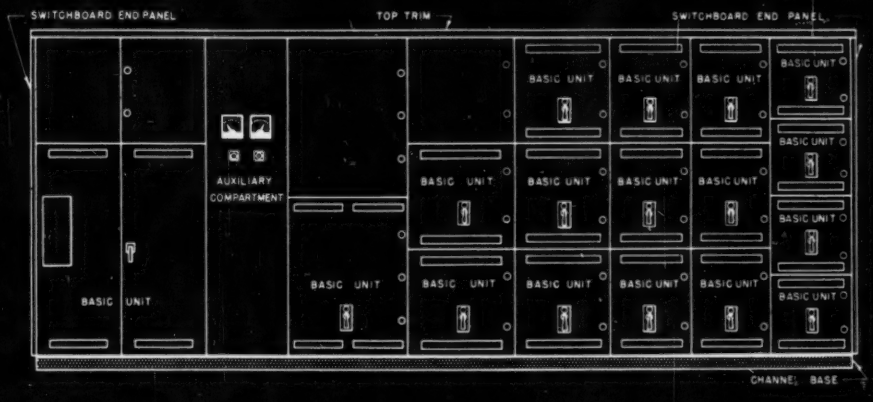

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Systems Engineering at The Ramo-Wooldridge Corporation

ICBM and IRBM are prime examples ■ The Intercontinental Ballistic Missile and the Intermediate Range Ballistic Missile, Air Force programs for which we have over-all systems engineering and technical direction responsibility, are prime examples of programs that require the systems engineering approach. Most Ramo-Wooldridge work is of such a systems character, requiring the concurrent solution of a wide variety of interrelated technical and operational problems. Additional examples at R-W are communications, fire-control, and computer programs for the military, and automation and operations research projects for business and industry.

Pertinent technical fields ■ Successful execution of systems engineering programs requires that the technical staff include experts in a considerable number of scientific and engineering specialties. At Ramo-Wooldridge some of the pertinent fields are aerodynamics, propulsion, digital computers, information theory, radio propagation, radar, infrared, servomechanisms, gyroscopy, and nuclear physics.

The kind of team required ■ A qualified systems engineering staff must include unusually capable theoreticians and analysts who can predict the behavior of complex systems, as well as ingenious experimental physicists who can devise suitable new techniques for measuring actual physical parameters. In addition, the team must include experienced apparatus and equipment development engineers, to insure a high level of practicability in the resulting end products.

Scientists and engineers who are experienced in systems engineering work, or who have specialized in certain technical fields but have a broad interest in the inter-actions between their own specialties and other fields, are invited to explore the wide range of openings at The Ramo-Wooldridge Corporation in:

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Prometheus, one of the earliest characters in classical mythology, gave the gift of fire to mortals and was punished for this infringement on the gods. He was bound to a rock to be devoured by an eagle and by the elements. But Prometheus persevered over all. His name still symbolizes enormous endurance over incredible hardship.

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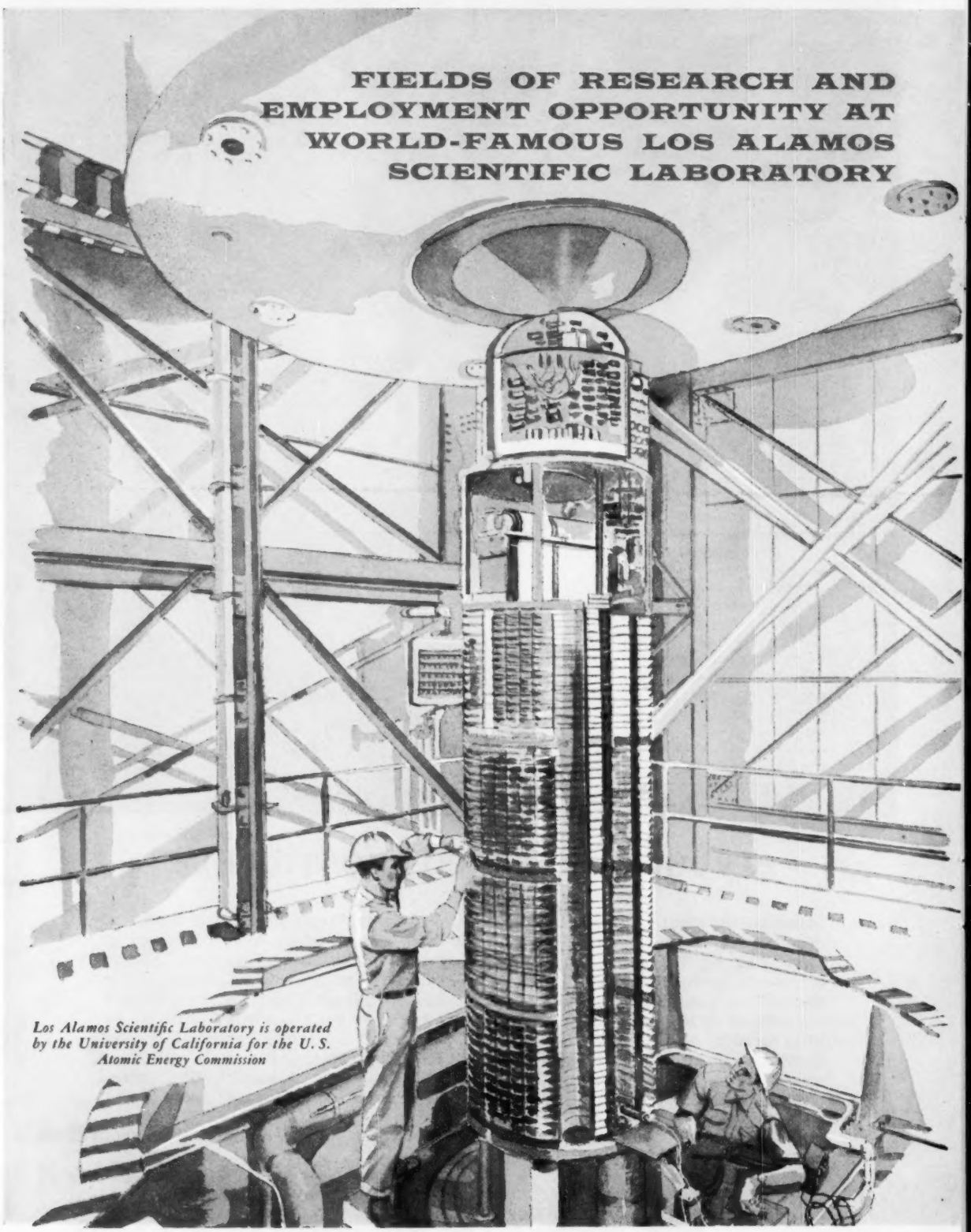
FIELDS OF RESEARCH AND EMPLOYMENT OPPORTUNITY AT WORLD-FAMOUS LOS ALAMOS SCIENTIFIC LABORATORY
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Theoretical Physics and Mathematics

In the field of theoretical physics, the Laboratory carries on studies of nuclear theory, equations of state, mathematical analysis methods, hydrodynamics problems and various aspects of applied mathematics. The Theoretical Division is also concerned with the conceptual design of nuclear weapons, and supports many non-weapons activities such as the nuclear reactor and propulsion programs. The equipment used includes the Los Alamos-developed Maniac, the Maniac II, two IBM 704's and an IBM 701.

Experimental Nuclear Physics

Much of the work in experimental physics is concerned with nuclear properties of various materials. Fundamental studies are made of nuclear forces, neutron and charged-particle reactions and cross sections. Experimentation in controlled thermonuclear reactions is assuming increasing importance. Among the facilities available are three Van de Graaffs, two Cockcroft-Walton machines and a variable energy cyclotron.

Electronics and Instrumentation

The Laboratory is engaged in the design and development of nuclear physics research instruments, scintillation counters, fast pulse amplifiers, multi-channel analyzers, fast oscilloscopes, radiation detection instruments, electronic controls and control systems, and high-speed cameras which operate at 15 million frames per second. Electronics specialists also assist in the design of digital computers and of instruments for studying nuclear and thermonuclear detonations.

Nuclear Reactor Research

In connection with the peacetime applications of nuclear energy, the Laboratory is currently developing several advanced power reactors of unusual design. In addition, two research reactors are available for experimental studies. The remotely controlled critical assembly machines, known as Topsy, Godiva and Jezebel, constitute neutron research tools of a unique character.

Nuclear Propulsion

The Laboratory is actively engaged in the application of nuclear energy to the new and challenging field of self-propelled mobile reactors. There are studies in progress relative to engine design, heat transfer, controls and instrumentation.

Chemistry

Research in chemistry is devoted largely to inorganic and physical studies, especially of materials such as uranium, plutonium, deuterium and tritium used in nuclear energy systems. Radiochemical methods are applied in various investigations. Much work is being done on reaction kinetics, the effects of radiation on chemical reactions, complex ion formation and the determination of heats of combustion and solution. Extensive analytical studies include the use of a great variety of instruments, as well as the techniques of microanalysis.

Metallurgy and Metallurgical Engineering

Research activity and development in this field includes investigation of the metallurgical properties of materials used in nuclear energy systems; studies of extremely refractory substances, ceramics, cermets and plastics; the behavior of materials under extremely high temperatures and high pressures; studies of the properties of plutonium and its alloys, with increasing reference to their use in reactors, and of uranium and its alloys; development of fabrication techniques for various metals and alloys; and the high temperature properties of refractory metals tungsten, molybdenum, columbium, etc.

Weapons Physics, Design and Testing

Still the nation's principal institution for nuclear and thermonuclear weapons research, the Laboratory takes nuclear weapons from the concept stage to proved performance as determined by field tests. Activities in weapons research and development include the mechanics and dynamics of initiating a nuclear energy release; the behavior of supercritical systems; the testing of nuclear devices and weapons assemblies in Nevada and in the Pacific; engineering design of tests and prototypes of nuclear systems; and the design and development of nuclear weapons components and the techniques for their manufacture.

Explosives Research and Development

Work in this field includes study of fabrication, storage and stability problems of explosives; making and evaluating novel organic chemical compounds of possible use as explosives; mechanics and dynamics of explosive phenomena; and physical and chemical properties of explosive material using mass spectrometer, infra-red spectrometer, X-ray equipment and other analytical techniques. High explosives are employed in research on equations of state and shock wave phenomena.

Mechanical Engineering

Design and development work is carried on in connection with weapons design, field test facilities, the power reactor and propulsion programs, servo-mechanisms and remote control systems. High explosives systems are designed and manufactured. Other types of work are estimating, cost analysis and liaison between architectural engineers and contractors.

Chemical Engineering

Chemical engineering work includes studies of heat transfer, fluid flow, solvent extraction, evaporation, distillation and systems at extreme temperatures and pressures. Problems supporting inorganic and physical chemistry research projects are also undertaken. Other activities are the remote control handling of radioactive materials and corrosion and erosion studies.

Electrical Engineering

Much effort is devoted to the design of induction heating systems for study of alloys at extremely high temperatures; of DC power supplies at currents up to 100,000 amperes; of servomechanism controls for nuclear reactors; and of high magnetic field systems. Work is done in planning, building and installing power distribution systems and their controls.

The Laboratory now has staff openings for technically qualified people interested in these fields of research and development. For additional information address your inquiry to

Director of Personnel
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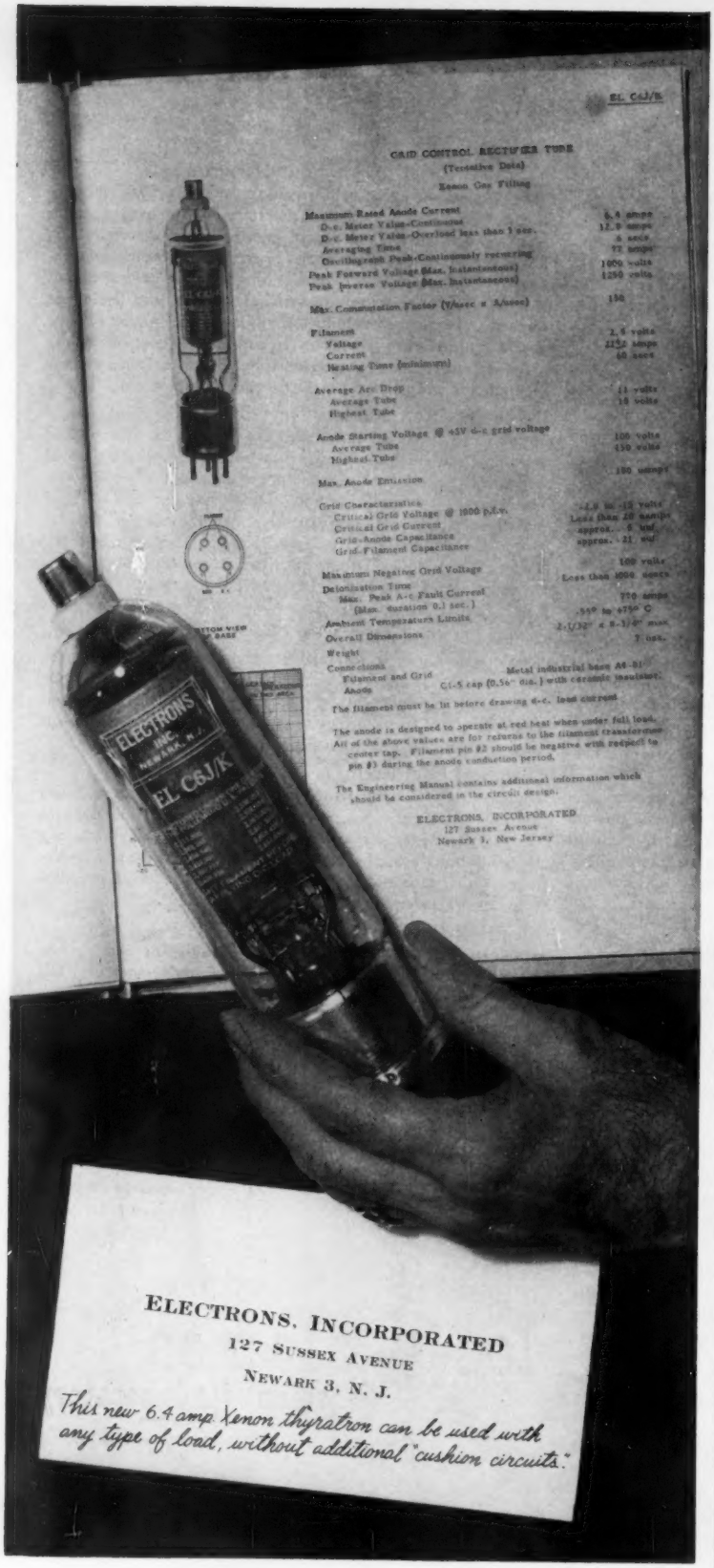
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Maximum Rated Anode Current 6.4 amps
D-c. Meter Value-Continuous 12.8 amps
D-c. Meter Value-Overload less than 1 sec. 6 secs
Averaging Time 72 amps
Oscillograph Peak-Continuously recurring 1000 volts
Peak Forward Voltage (Max. Instantaneous) 1250 volts
Peak Inverse Voltage (Max. Instantaneous) 150
Max. Commutation Factor (V/usec x A/usec)
Filament
Voltage 2.5 volts
Current 12.5 amps
Heating Time (minimum) 60 secs
Average Arc Drop
Average Tube 11 volts
Highest Tube 18 volts
Anode Starting Voltage @ +5V d-c grid voltage
Average Tube 100 volts
Highest Tube 150 volts
Max. Anode Emission 100 amps
Grid Characteristics
Critical Grid Voltage @ 1000 p.f.v. -2.0 to -15 volts
Critical Grid Current Less than 20 amps
Grid-Anode Capacitance approx. 6 mmf
Grid-Filament Capacitance approx. 21 mmf
Maximum Negative Grid Voltage 100 volts
Deionization Time Less than 1000 usecs
Max. Peak A-c Fault Current 770 amps
(Max. duration 0.1 sec.)
Ambient Temperature Limits -55° to +75° C
Overall Dimensions 2-1/32" ± 1/8" max.
Weight 7 ozs.
Connections
Filament and Grid Metal industrial base A6-01
Anode CC-5 cap (0.56" dia.) with ceramic insulator
The filament must be lit before drawing d-c. load current
The anode is designed to operate at red heat when under full load.
All of the above values are for returns to the filament transformer center tap. Filament pin #2 should be negative with respect to pin #3 during the anode conduction period.
The Engineering Manual contains additional information which should be considered in the circuit design.
ELECTRONS, INCORPORATED
127 Sussex Avenue
Newark 3, New Jersey
ELECTRONS INC. NEWARK, N.J.
EL C6J/K
ELECTRONS, INCORPORATED
127 SUSSEX AVENUE
NEWARK 3, N. J.
This new 6.4 amp Xenon thyratron can be used with any type of load, without additional "cushion circuits."

▲ Circle 46 on the card.

New Products

(*Continued from page 34A*)

Load Centers. This line, manufactured by the Square D Company features the QO panelboard breaker. The QO's swingrip mounting feature assures proper positioning of the breaker and a firm, positive connection in one simple operation. Its noninterchangeability feature discourages the substitution of 30, 40, or 50 ampere (amp) breakers where 15 or 20 amp

devices originally have been installed. In addition, the QO incorporates quick-make and quick-break, ambient-compensated and thermal-magnetic features. The QO's use in the new, complete load center line makes available a wide range of devices for residential, commercial, and light industrial applications. The QO line is Underwriters' Laboratories approved and meets Federal Specification WP-A131A, Class A.

▲ Item 47 on the card.

Transistor for Automobile Radios. The CBS *2N155*, a power transistor designed especially for the audio output stage of automobile radio receivers, is being manufactured by CBS-Hytron, a Division of Columbia Broadcasting System, Inc. These transistors will be used in 1957 car radios. Designed to operate from a 12-volt battery, this *p-n-p* germanium-alloy junction transistor features high power gain, uniformity, and exceptional reliability. It is plug-in for easy installation. Highly efficient heat dissipation is characteristic of the unit. Its heavy copper flange mounting permits heat flow from the power transistor to the chassis, thus providing a large radiating area. Additional data can be obtained by requesting engineering bulletin *E-259*.

▲ Item 48 on the card.

Miniaturized Electric Eyes. Designed to render long maintenance-free service and to be mounted in hitherto impossible spaces ESS miniaturized electric eyes are so small they fit into the palm of a hand. They offer industry a low-cost practical approach to monitoring, counting, or positioning of any objects passing or dropping through a light beam. They may be used to operate relays when a

(*Continued on page 56A*)

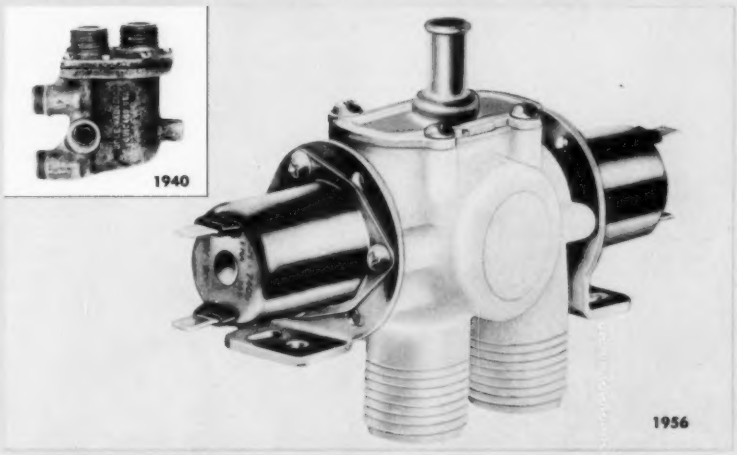
Circle 49 on the card ▶

DU PONT
REG. U.S. PAT. OFF.
Better Things for Better Living ... through Chemistry

ELECTRICAL MANUFACTURING NEWS

PROPERTY AND APPLICATION DATA
ON THESE VERSATILE ENGINEERING MATERIALS:
"ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Housing of ZYTEL® nylon resin for solenoid-operated valve offers economy, design simplicity



Note design change in solenoid-operated water control unit in past sixteen years. Housing of "Zytel" replaces brass in automatic home washing machine valve. (*Molded by Chicago Molded Products Corporation for The Dole Valve Company, Chicago 12, Illinois.*)

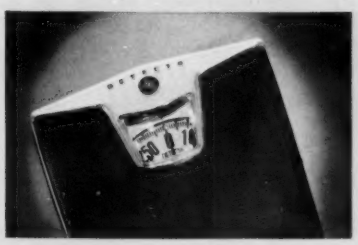
The unique combination of properties of "Zytel" nylon resin makes it particularly adaptable to this new valve body design. "Zytel" is easily and inexpensively injection molded to close tolerances. "Zytel" is tough, abrasion resistant, strong in thin sections, light in weight and offers good chemical resistance. It provides quiet operation with little or no lubrication, and possesses good insulating characteristics.

The molded threads on the two inlets in the solenoid-operated water control unit pictured above provide a strong, leak-proof connection when used with a standard hose coupling. The resistance of "Zytel" to water and chemicals prevents corrosion. Even in hard water areas, these valve bodies are unaffected by deteriorating action of minerals present. Typical results of proper application of Du Pont "Zytel" nylon resin such as in this molded valve housing are production and maintenance economies and reduced replacement costs.

"Zytel" also has a wide variety of applications in the electrical field. Its good dielectric properties are utilized in coil forms, connectors, and conduit fittings. A thin coating of "Zytel" provides insulation and resistance to abrasion for electrical wire.

Perhaps "Zytel" can offer savings and increased performance in your product. Clip and mail the coupon on the other side of this page for complete property and application data.

OVER



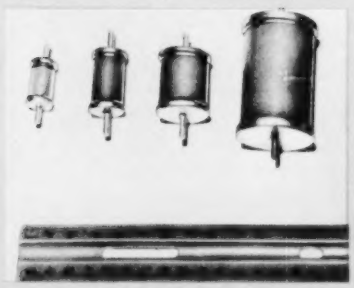
Beauty of LUCITE® acrylic resin adds a distinctive and decorative touch to manufacturers' emblems. "Lucite" resists chipping, cracking and crazing . . . can be molded in a wide variety of transparent, translucent and opaque colors. An emblem of "Lucite" gives sparkling identification. (*See—Deep emblem molded by Hoosier Cardinal Corporation, Evansville, Indiana for Detecto Scales Company, Brooklyn 5, New York.*)

Superior capacitor dielectrics made possible by unique properties of TEFLON®

The physical, chemical, and electrical properties of Du Pont "Teflon" tetrafluoroethylene resin make "Teflon" an outstanding insulation at high temperatures. "Teflon" remains flexible through a wide temperature range, from 500°F. to —450°F. Du Pont "Teflon" is inert to virtually every commercially employed chemical or solvent.

"Teflon" has zero moisture absorption by A.S.T.M. test, good mechanical strength, low dielectric absorption, small voltage derating factor for high temperature operation, high insulation resistance, and a low loss factor. In combination with other materials, "Teflon" is used for power and transmitting applications and for pulse-forming networks.

The properties of "Teflon" are applicable to a variety of uses in the electrical field—in applications where miniaturization and compactness of design are essential, and for uses where equipment is exposed to corrosive action. "Teflon" is unaffected by sunlight or outdoor weathering. Specific electrical uses include insulation and molded parts for all types of motors, transformers and other equipment; and coaxial cables for radar and television.



These typical capacitors of "Teflon" range in size from .001 mfd at 24,000 volts to .0004 mfd at 6,000 volts. (*Manufactured by Condenser Products Co., Division of New Haven Clock and Watch Co., New Haven, Connecticut.*)

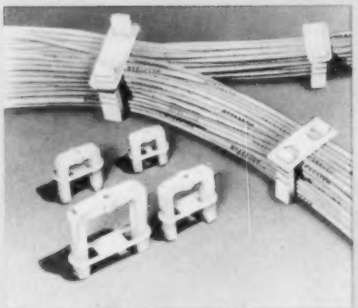
Complete property and application data on this versatile Du Pont engineering material are available. Clip and mail coupon.

DU PONT
REG. U.S. PAT. OFF.
Better Things for Better Living ... through Chemistry

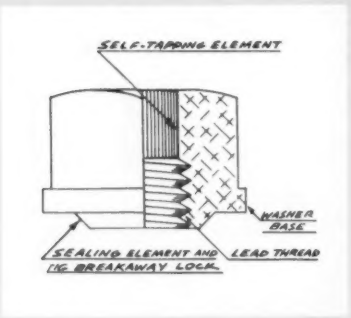
ELECTRICAL MANUFACTURING NEWS

PROPERTY AND APPLICATION DATA
ON THESE VERSATILE ENGINEERING MATERIALS:
"ZYTEL," "ALATHON," "TEFLON," "LUCITE."

No. 4, 1956



The solvent and fuel resistance of ZYTEL® nylon resin make these Type-U clamps particularly valuable in a wide variety of wiring applications. They eliminate tying wire bundles; cut costs by speeding application and reducing tool requirements. (*Manufactured by Dakota Plastics Company, Compton, California.*)



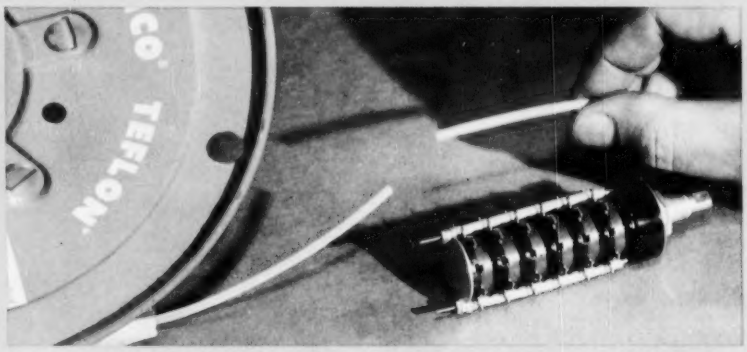
Brilok® self-tapping stop nuts of molded ZYTEL® nylon resin lock, seal and insulate. They lock at any position along the shank of the screw. As the screw turns into the resilient "Zytel", a counter-compressive force is built up, resulting in a tight friction lock. Further tightening will cause the cone at the base of the nut to extrude into the clearance spaces. This forms a highly effective seal against liquid or gas escape, or the entrance of corrosive influences.

Stop nuts of "Zytel" are used in all types of equipment and especially in applications where conditions require toughness, extreme light weight, stability at high temperatures, abrasion resistance, corrosion resistance, and strength in thin sections. (*Manufactured by Byrd Plastics Inc., Erie, Pa. Distributed by American Screw Co., Willimantic, Connecticut.*

NEED MORE INFORMATION?

Clip the coupon for additional data on the properties and applications of these DuPont engineering materials.

Thin-walled tubing of TEFLON® withstands soldering temperature, simplifies component parts assembly



Sleeve of "Teflon", with a wall thickness of only .014" and a nominal inside diameter of .075", serves as an insulator around two stainless steel studs in miniature rotary tap switches designed for use in military aircraft.

"Teflon" tetrafluoroethylene resin maintains a high dielectric strength at elevated temperatures. It also has high surface resistivity, dropping only to 10^{13} ohms at 100% relative humidity. Tubing of "Teflon" maintains full electrical insulating characteristics even when flexed or bent during assembly and installation. This combination of properties makes it possible to miniaturize an electrical assembly without fear of dielectric failure.

Du Pont "Teflon" provides the answer to an insulation problem in a series of miniature rotary tap switches. In this application, "Teflon" features its exceptional thermal stability. It is suitable for use at extreme service temperatures ranging from a high of 500°F. to —450°F. Tubing of "Teflon" will not melt, burn, decompose, or retract along the wire when a connection is soldered, thereby eliminating the possibility of accidental grounding. It meets Class H, AIEE standards for maximum hot spot insulating temperatures.

(*These miniature units are manufactured by Grayhill Company, LaGrange, Illinois. Tubing supplied by The Polymer Corporation of Pennsylvania, Reading, Pennsylvania, under their trademark*, Polypenco.)

"Teflon" is chemically inert—resists corrosion and growth of fungus. It has zero water absorption by ASTM test D570-42. It is non-flammable, has good mechanical strength and is completely unaffected by sunlight or outdoor weathering.

"Teflon" is applicable to a variety of uses in the electrical field. You can profitably use this versatile Du Pont engineering material in applications involving miniaturization; high-frequency, high-voltage, and high-temperature requirements; exposure to corrosive action. Send coupon below for complete statistical data and case histories as a guide to proven applications of "Teflon".

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
ROOM 202, Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada, Ltd., P. O. Box 660, Montreal, Quebec

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel"* ☐ *"Teflon"* ☐ *"Lucite". I am interested in evaluating these materials for:*

NAME _____ POSITION _____

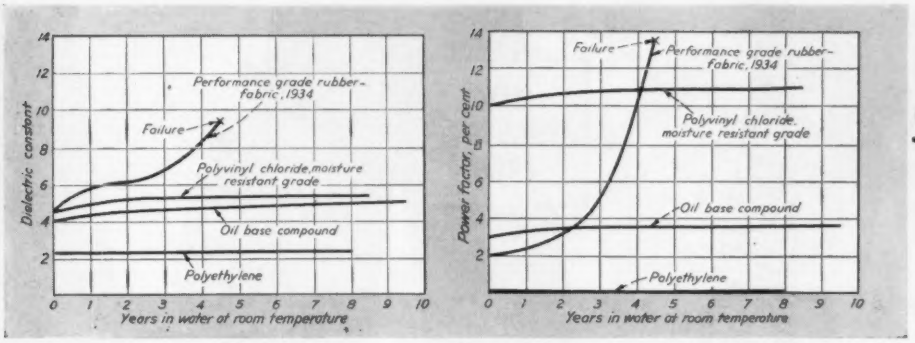
COMPANY _____

STREET ADDRESS _____

CITY _____ STATE _____

TYPE OF BUSINESS _____

"Zytel", "Lucite", "Teflon" are registered trademarks of E. I. du Pont de Nemours & Co. (Inc.)



CURRENT TRENDS

No. 3 in a series of articles

These graphs show some long-time 1000-cycle test results on typical insulations. Time consumed retards development of new types. The text explains limitations of accelerated tests and how interpretation is affected by application.

Moisture Resistance of Cable Insulations

In sharp contrast to the situation only 15 to 20 years ago, moisture need no longer be considered a serious hazard to cable operation.

Two factors have helped materially in the relatively rapid attainment of this present degree of protection: (1) New insulating materials and compounds have been developed which possess an inherent high degree of moisture stability; (2) Short-term laboratory test methods now help to evaluate moisture resistance correctly and thereby speed the development of the newer insulating materials.

Metallic sheaths—pro and con

A continuous metallic covering, such as lead sheath inherently provides complete moisture protection to the underlying insulation. But a metallic sheath is not always advisable or practicable. Hazards such as electrolysis, corrosion, vibration, plus added weight and economic factors often nullify its usefulness. This seems to be more the rule than the exception.

Because of these problems presented by metallic sheaths, attention turned to the study of the ability of the conductor insulation itself and nonmetallic coverings to withstand water and moisture. These studies involved the theories of mechanics of moisture attack, effects of environmental conditions, methods of test, and evaluation of insulating materials and coverings with particular relationship to actual performance and experience.

Theories

The mechanics of water absorption have been comprehensively investigated. While there is a lack of agreement in terms of actual operation, it is generally agreed that there are at least two physical methods by which water might affect insulation: by actual "absorption" and "diffusion."

"Absorption" is a direct layer effect in which the successive outer layers of the insulation gradually become water-soaked. Tests for increased weight or electrostatic capacitance of the dielectric reflect changes by absorption.

"Diffusion"—more difficult to measure—takes place when water permeates the insulation and establishes irregular conducting paths of water from the conductor to the outer surface. Its study involves additional parameters such as pressure and rate. A weight test would not disclose "diffusion" but some sensitive electrical quantity such as insulation power factor or resistivity might be related to it.

The effect of moisture upon cable characteristics can probably be best explained in terms of its electrical action which provides a direct determination. The insulating properties of a dielectric are adversely affected by the conducting properties of the water.

The determining feature for any insulation operating under an alternating current stress is its electrical stability. For as soon as its insulation becomes erratic under a particular set of circuit conditions, a cable's usefulness to that circuit is ended. For a power cable, complete electrical instability is reached when dielectric losses become excessive enough to permit actual thermal failure. For a communication cable, this point is reached when attenuation constants increase so much that an acceptable level or quality of signaling cannot be maintained.

In cable insulation it is not so much a question of "how much" water, as "where" it is. The ultimate criterion in the penetration of water through cable insulation, therefore, *is its effect upon the electrical stability of the cable—all other effects being of secondary importance.* The longer the electrical properties of an insulation remain relatively constant in the presence of water, the better is the true moisture resistance of that insulation.

Long-term unaccelerated moisture tests have been fundamental and helpful in adding to the knowledge of moisture absorption. But a minimum of two years' immersion period has usually been necessary to establish whether or not an insulation was truly electrically stable—and many such tests have been continued on many types of insulations for 5-year periods and longer. Something of a more practical nature was obviously needed and several short-term test methods, based upon electrical measurements were devised and found to give a relatively truthful index of moisture resistance.

Test methods

One such short-term test control is the temperature of the water bath. This has been found to have a substantial accelerating influence, although certain caution is needed in establishing a maximum test temperature that will not alter results because of chemical or physical changes. For most materials and purposes, a bath temperature of 50° C. has been found satisfactory. Further, the effects of thickness of insulation are reflected in the rate of change of electrical properties. Relatively thin walls (preferably not less than 1/32") will disclose the effects of water much sooner than heavier walls which may require several months immersion to indicate a correct trend of measurements.

In performing electrical measurements, an increase in the applied test voltage will generally cause a truthful "acceleration." For example, measurements of power factor and capacitance at 60-cycle voltages up to 80 volts per mil of insulation thickness provide a reliable means of testing insulated conductors intended for 60-cycle power service applications.

An electrical test which consists of measurements of 60-cycle capacitance and power factor at 40 and 80 volts per mil on cable specimens immersed in water at 50° C. is now the only moisture test recommended by IPCEA for power and control cables. It is sometimes called the Stability Test. Details and limits for this and other tests are set forth in the recent IPCEA wire and cable specifications, Appendix N—Method EM-60.

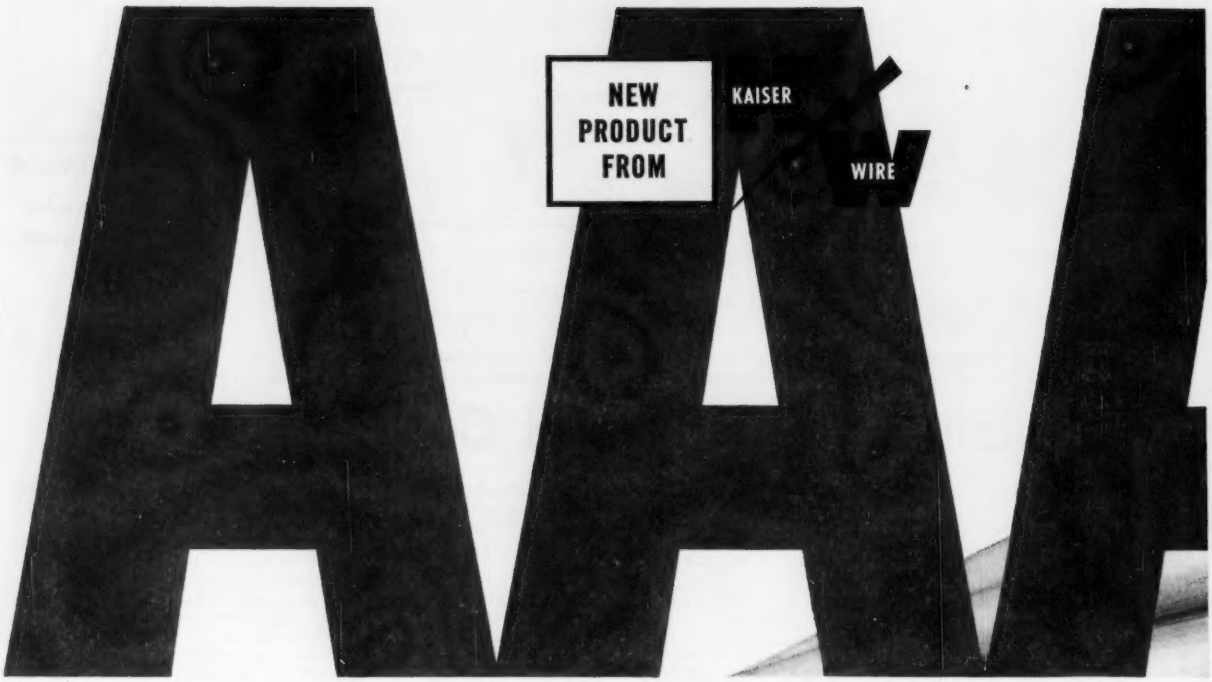
In conclusion

The various possible effects of moisture on insulation involve a careful analysis of the end use before choosing materials and design. But it is certain, at least, that specification of lead sheathed cable designs is no longer mandatory for wet locations. And there is no question that we are headed for still better moisture-resistant insulations—and better tools aiding our understanding of the problem of moisture.

For further study of this subject reference is made to a paper entitled, "What Moisture Resistance Means in Cable Insulation" by R. C. Graham, Chief Engineer, Rome Cable Corporation, which we will gladly send on request.

ROME CABLE CORPORATION, Rome, New York

For more information circle 50 on reader service card.



How does it compare with

WHAT IS AAAC?

AAAC is a high-strength, high-electrical conductivity heat-treatable aluminum-magnesium-silicon alloy developed by Kaiser Aluminum. Through the combination of proper heat treatment and cold reduction, wire is produced having exceptional mechanical strength yet with electrical conductivity only moderately reduced from that of pure E.C. aluminum.

HOW DOES AAAC COMPARE IN EFFICIENCY?

$$\frac{\text{Tensile Strength} \times \text{Conductivity}}{\text{Specific Gravity}}$$

The above formula may be looked upon as a rough criterion for conductor metal efficiency in high tensioned overhead line construction. Using this efficiency criterion, AAAC is:

1. almost 50% more efficient than hard-drawn copper
2. almost twice as efficient as E.C. aluminum
3. about 25% more efficient than ACSR.

DOES AAAC HAVE INSTALLATION ADVANTAGES?

AAAC is as simple to splice and dead-end as all-aluminum or copper cables. For splicing, *only a single compression sleeve is required.* This eliminates the separate steel sleeve and the cutting back of strands necessary when splicing ACSR. Automatic or preformed splices can develop the full strength of the conductor without special preparation. For dead-ending, suitable bolted-type clamps can develop the full conductor strength. All this means that in many cases fittings will be less costly than those for ACSR, installation time will be less, and rapid emergency repairs may be made more quickly even when the line must remain energized during repair. Armor rods satisfactorily used on ACSR can also be used on AAAC. Repair sleeves, armor rods, clips, Corona balls and dampers are interchangeable because of equivalent sizes.

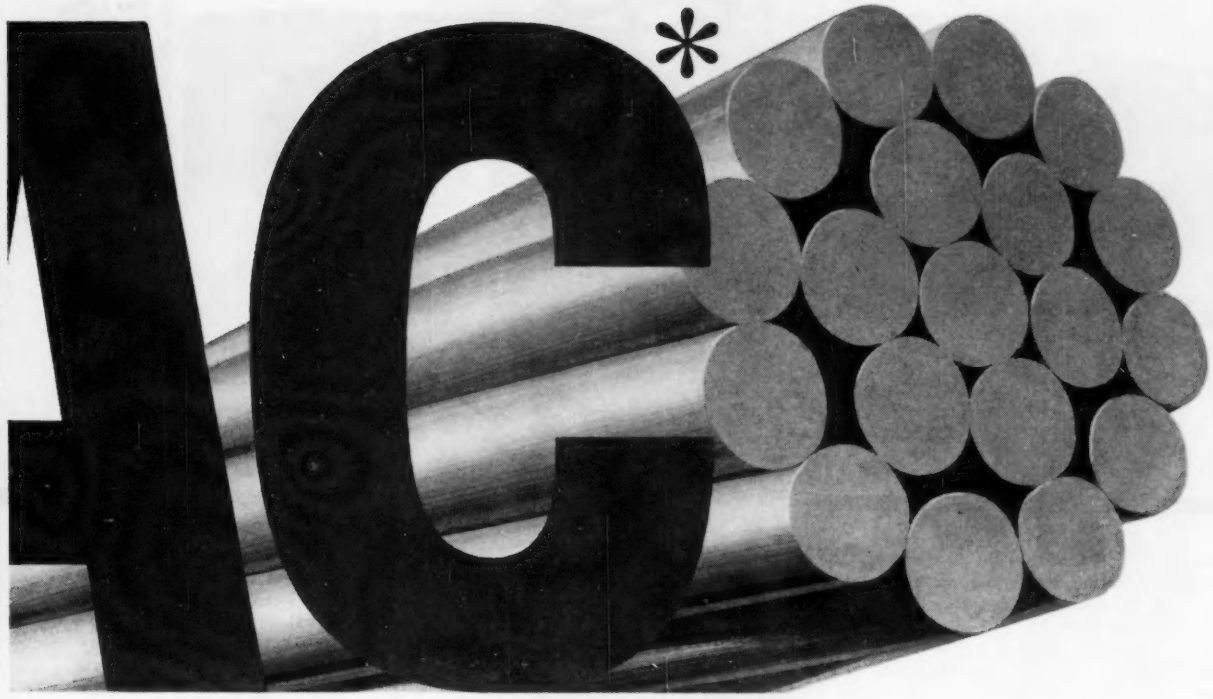
WHAT ABOUT SIZES?

AAAC is designed in sizes to be approximately equivalent to ACSR conductors (in outside diameter, d-c resistance and breaking strength).

	SIZE	DIAM. (IN.)	STRENGTH (LBS.)	R-DC @ 20°C OHMS/1000 FT.	WEIGHT LBS/1000 FT.
ACSR	6-6/1	0.198	1170	0.6580	36.1
AAAC	6-7	0.197	1068	0.6580	28.2
ACSR	2-6/1	0.316	2790	0.2602	91.3
AAAC	2-7	0.314	2700	0.2602	71.4
ACSR	1/0-6/1	0.398	4280	0.1635	145.2
AAAC	1/0-7	0.395	4290	0.1635	112.4
ACSR	4/0-6/1	0.563	8420	0.0816	291.1
AAAC	4/0-7	0.565	8430	0.0816	232.1

* *The initials AAAC are not a trade-mark of Kaiser Aluminum, but are regarded as a grade designation for All Aluminum Alloy Conductor (developed by Kaiser Aluminum). The initials are intended to be used freely throughout the industry in designating such products, as is the case with grade designation ACSR, Aluminum Conductor, Steel Reinforced. While testing continues AAAC will be available in limited quantities through Kaiser Aluminum sales offices and distributors; redraw rod will later be available to other fabricators of electrical conductor.*

For more information circle 51 on reader service card.



other forms of conductor?

WHAT IS THE CORROSION RESISTANCE OF AAAC?

AAAC is mono-metallic and the alloy has great inherent corrosion resistance. Galvanic corrosion, that may sometimes occur between the steel core wires and adjacent aluminum strands in an ACSR conductor in severe environments, cannot take place with AAAC.

WHAT ABOUT THE OPERATING COSTS OF AAAC?

For the same current carried AAAC will operate cooler than ACSR with a cost-saving and lower watt loss per foot of conductor. Inductive reactance of AAAC at one foot spacings is approximately 10% lower than the equivalent ACSR and, for a given length, will have less voltage drop.

HOW DURABLE IS AAAC?

AAAC has about twice the Brinell hardness of hard-drawn E.C. aluminum. It will, therefore, not abrade so readily as all-aluminum or ACSR conductors during installation nor will it wear to the same extent in ties, dead-ends and clamps.

HOW DOES AAAC COMPARE IN TENSILE STRENGTH?

Since AAAC has the same metal area as ACSR and has the same composite strength, the conductor strength will be the same as its ACSR equivalent. This value is shown in the table where the size comparison is made.

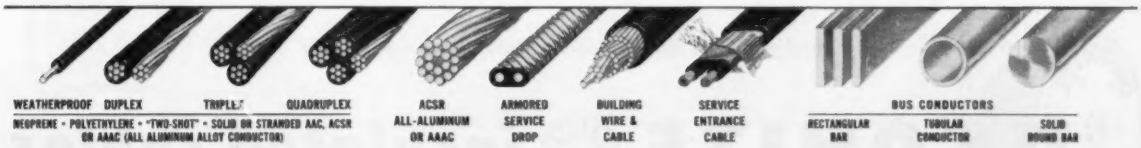
For more detailed information about this important new Kaiser Aluminum development, see any Kaiser Aluminum sales office or one of our many distributors.

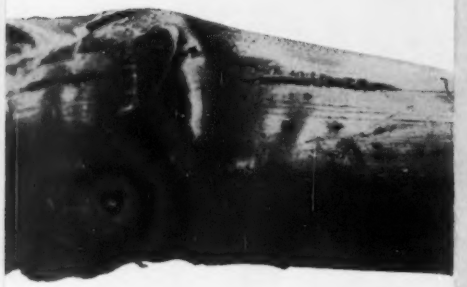
Kaiser Aluminum & Chemical Sales, Inc., *Executive Office,* Kaiser Bldg., Oakland 12, California; *General Sales Office,* Palmolive Bldg., Chicago 11, Illinois.

Kaiser Aluminum

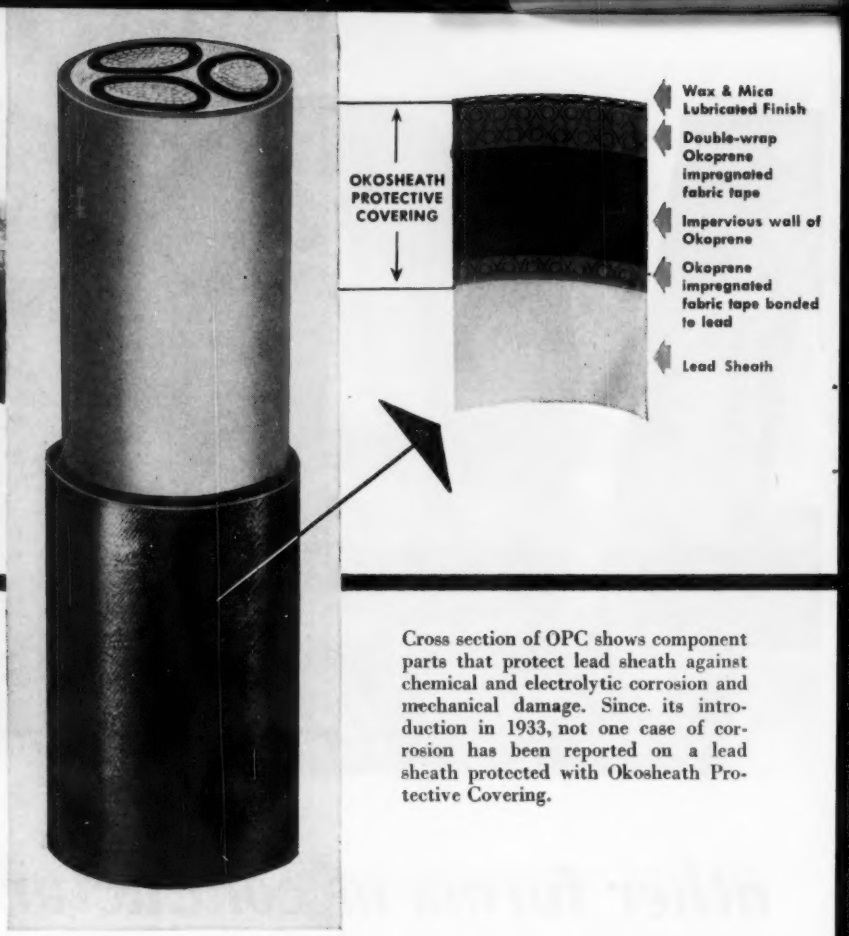
Aluminum is the answer to Adequate Wiring

See "THE KAISER ALUMINUM HOUR." Alternate Tuesdays, NBC Network. Consult your local TV listing.


WEATHERPROOF DUPLEX TRIPLEX QUADRUPLEX
NEOPRENE • POLYETHYLENE • "TWO-SHOT" • SOLID OR STRANDED AAC, ACSR OR AAAC (ALL ALUMINUM ALLOY CONDUCTOR)
ACSR ALL-ALUMINUM OR AAAC
ARMORED SERVICE DROP
BUILDING WIRE & CABLE
SERVICE ENTRANCE CABLE
BUS CONDUCTORS
RECTANGULAR BAR
TUBULAR CONDUCTOR
SOLID ROUND BAR



This unprotected lead sheath was scored during installation. Corrosion concentrated at the score mark and caused failure. In contrast the lead sheathed cable (at right) is covered with Okosheath Protective Covering, which prevents such mechanical injury.


OKOSHEATH PROTECTIVE COVERING
Wax & Mica Lubricated Finish
Double-wrap Okoprene impregnated fabric tape
Impervious wall of Okoprene
Okoprene impregnated fabric tape bonded to lead
Lead Sheath

Cross section of OPC shows component parts that protect lead sheath against chemical and electrolytic corrosion and mechanical damage. Since its introduction in 1933, not one case of corrosion has been reported on a lead sheath protected with Okosheath Protective Covering.

why Okosheath Protective Covering *eliminates lead sheath failure caused by scoring and corrosion*

Service records dating back to 1933 prove that Okosheath Protective Covering prolongs the life of paper-insulated lead sheathed cables for three main reasons.

1. Eliminates chemical corrosion—the substantial wall of Okoprene, free from fibrous materials that can wick-in moisture, is completely vulcanized and meets all the ASTM requirements for neoprene cable coverings. Okoprene provides excellent resistance to alkalies and acids in the soil. Firmly bonded by vulcanization to the sheath, it prevents any corrosive elements from contacting the lead and causing corrosion.

2. Stops electrolytic damage—the dense, homogeneous wall of Okoprene possesses stable electrical insulating properties which prevent electrolysis caused by stray currents. It is applied by Okonite's well-known strip-insulating process which assures a uniform wall thickness with no thin spots over the lead sheath.

3. Prevents scoring of lead—because unprotected lead sheathed cable is vulnerable to scoring from abrasion during installation, its ability to resist internal pressure is greatly reduced. In tests, lead pipe sections having controlled score marks of 10% and 15% of their average thickness and subjected to internal pressure broke 17% and 31% sooner, respectively, than unscored pipes of identical thickness. The composite reinforced wall of Okosheath Protective Covering eliminates this possibility of mechanical damage to the lead sheath. In addition, pulling problems are reduced because the two outer layers of heavy fabric tape are slushed with a wax and mica finish.

For additional information on Okosheath Protective Covering write for Bulletin EG-1047, **Address: The Okonite Company, Passaic, N. J.**

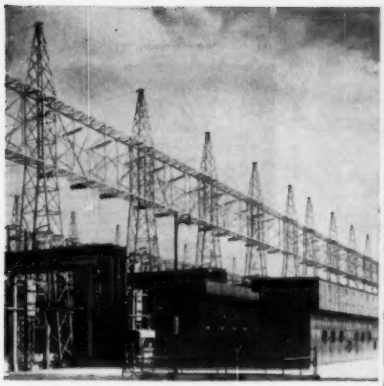
available with either copper or aluminum conductors

3912

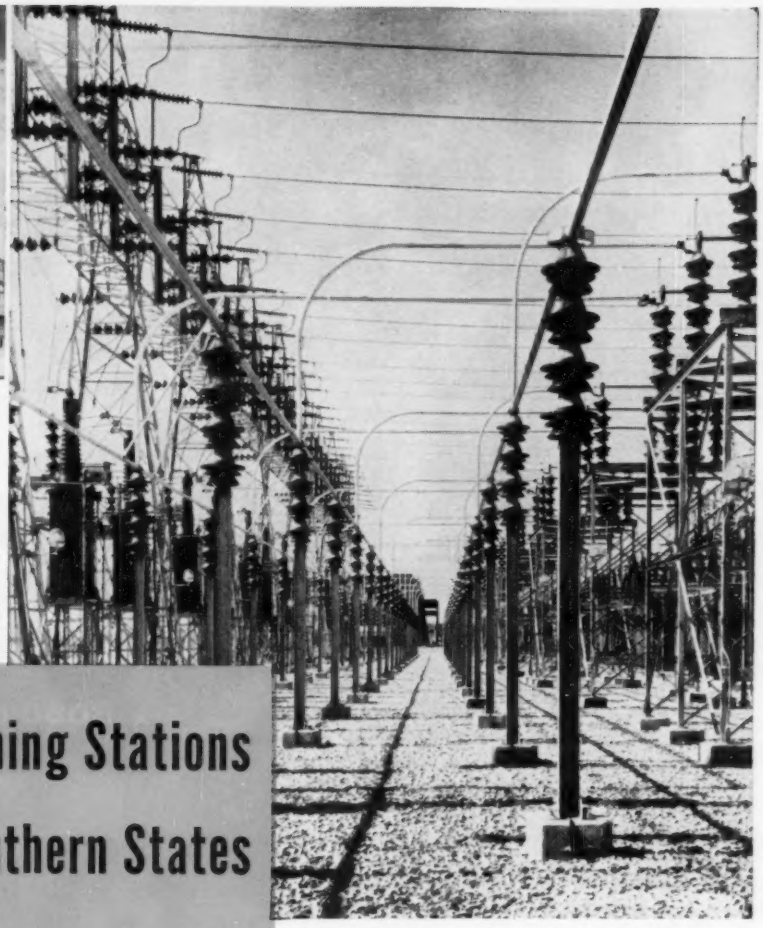
OKONITE insulated cables

SINCE 1878

For more information circle 52 on reader service card.



PADUCAH, KY.—AEC plant's 25-acre switchyard where two stations supplied by Southern States use a total of 128 Type WAG Air Break Switches.



Paducah Switching Stations Supplied by Southern States

THE ATOMIC ENERGY COMMISSION'S plant at Paducah, Kentucky, has about 25 acres of electrical switchyards. Power fed through the yards is about 17 billion kwh annually. The structures and much equipment for two switchyards in this AEC development were supplied by Southern States—C-31 with 500,000 kva capacity, and C-33 with 1,000,000 kva capacity. Nearly a million pounds of steel were required for the two structures which occupy over one-quarter of a million square feet.

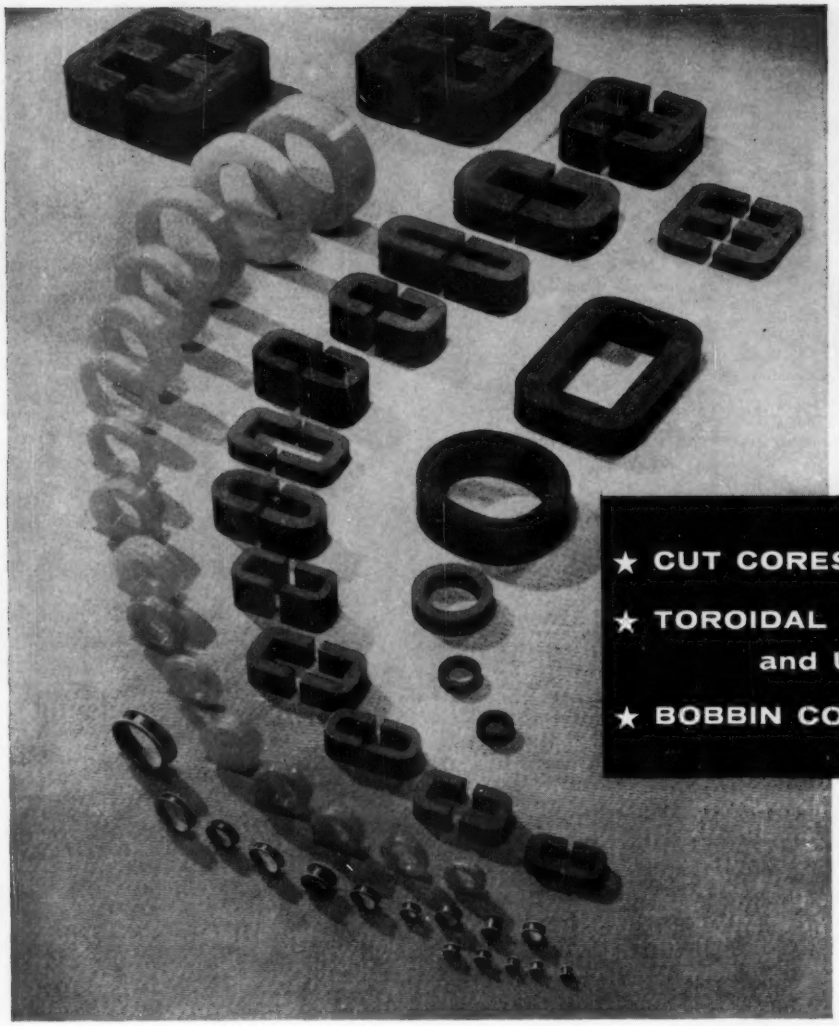
Among the Southern States equipment supplied with the structures were 128 Type WAG Air Break Switches. Of them, 121 were rated 161 kv-1200 amperes; four were rated 161 kv-600 amperes; and three 15 kv-2000 amperes.

This is another example where Southern States equipment was used for one of the nation's largest installations—a fact worth remembering when ordering or specifying equipment that demands dependability and performance.

SOUTHERN STATES EQUIPMENT CORP.
HAMPTON, GEORGIA

IN CANADA: Dominion Cutout Co., Ltd., Toronto

For more information circle 53 on reader service card.



★ CUT CORES, Types C and E

★ TOROIDAL CORES, Cased and Uncased

★ BOBBIN CORES

WESCON 1956 — August 21, 22, 23, 24, 1956 — LOS ANGELES CALIFORNIA

See us at BOOTH 913-914

It's ARNOLD for EVERYTHING in TAPE-WOUND CORES

Applications

Let us help you with your core requirements for Pulse and Power Transformers, 3-Phase Transformers, Magnetic Amplifiers, Current Transformers, Wide-Band Transformers, Non-Linear Retard Coils, Reactors, Coincident Current Matrix Systems, Static Magnetic Memory Elements, Harmonic Generators, etc.

For Complete Details

Write for Bulletins:

★ SC-107—Cut Cores, Types C and E
★ TC-101A—Toroidal Cores, cased and uncased
★ TC-108—Bobbin Cores

ADDRESS DEPT. EL-68.

MATERIALS: Deltamax, 4-79 Mo-Permalloy, Supermalloy, Mumetal, 4750, Monimax, Silectron, Permendur: all are available for cores depending upon the specific properties required.

GAUGES: The following standard tape thicknesses are available for Arnold tape wound cores in most of the magnetic materials mentioned above: .012", .004", .002", .001", .0005", or .00025". Bobbin cores are made from tape .001" to .000125" thick.

SIZES: Cores weighing from a fraction of a gram to many hundreds of pounds can be supplied. Toroidal cores are made in 27 standard sizes with nylon cases. Types "C" and "E" cut cores are made in a total of 530 standard sizes. Many special sizes and shapes of both gapless and cut cores are manufactured for unusual requirements.

OTHER PRODUCTS: In addition to Tape-Wound Cores, we also produce a complete line of Mo-Permalloy Powder Cores, Iron Powder Cores, and permanent magnets. • *Let us work with you.*

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SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

DISTRICT SALES OFFICES . . . New York: 350 Fifth Ave.

Los Angeles: 3450 Wilshire Blvd. Boston: 200 Berkeley St.

For more information circle 54 on reader service card.

DOW CORNING CORPORATION

Silicone Dielectrics

ELECTRICAL AND ELECTRONIC NEWS No. 7

Silastic Impregnated Sleeving Insulates Lead Wire In Strip Heater

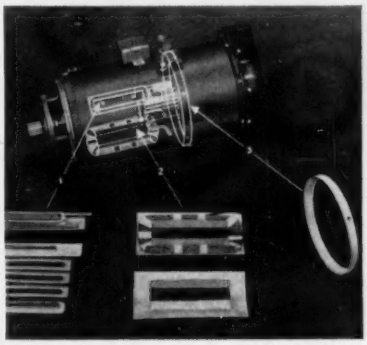
Braided glass sleeving impregnated with Silastic, Dow Corning's silicone rubber, retains excellent flexibility and insulating effectiveness at temperatures that cause rapid failure of organic electrical insulating materials. The advantages of such sleeving are demonstrated in the small strip heaters manufactured by Watlow Electric Co., of St. Louis.

Not much larger than elbow spaghetti, these efficient 175 watt heating units are used by aircraft builders and other metal working companies to heat aluminum during dimpling or countersinking to provide flush mounting of rivets. Most aluminum alloys cannot be formed cold without setting up stresses.

Slipped over the dimpling die-tips, the heaters produce temperatures of 500 F and higher. The lead wires flex continually with movements of the die. To protect the lead wire with a high dielectric strength material that retains good flexibility at high temperatures, Watlow uses Turbo 117, a Silastic impregnated sleeving fabricated by The William Brand Co. Watlow reports silicone insulated sleeving has substantially reduced lead wire failures. *No. 27*

CLASS H MOTOR STILL ON TEST AFTER 58,090 HOURS AT 240 C

At 10 A.M., June 6, 1946, a Class H insulated 10 hp motor was generator loaded to operate at its test temperature of 240 C in Dow Corning's motor test labs. Every 500 hours since it has been shut down and exposed to 100% relative humidity for 24 hours. As of 11 A. M. July 1, 1956, this motor was still on test after 58,090 hours at an average copper temperature of 240 C! That's equivalent to 353 years operation at the Class H temperature of 180 C.



Silicone-glass components: 1. interpole insulator; 2. shunt field coil insulator; 3. insulator ring.

SILICONE-GLASS LAMINATES CUT SIZE OF TURBOJET GENERATOR

By utilizing the superior thermal stability and dielectric strength of silicone-glass laminates, Red Bank Division of Bendix Aviation Corporation has designed new compactness and efficiency into a generator that meets the rugged requirements of turbojet operation.

This Type 30E10-1 Generator, a 30-volt 400 amp unit, is 6½ inches in diameter and weighs only 67 pounds. Developed to operate at speeds as high as 8000 rpm and for air-blast cooling at altitudes up to 65,000 feet, it features light weight insulating components formed of 2-ply silicone-glass cloth fabricated by Stevens Products, East Orange, N. J.

The extremely thin-walled construction of these parts provides more space for circulation of cooling air than possible with the several layers of tape conventionally used. In addition, the silicone-glass laminates are lighter in weight than the tape insulation. Quickly "snapped" into place, they effect substantial savings in assembly time and costs. *No. 28*

"Potting Gives Maximum Reliability", an article from ELECTRONIC EQUIPMENT, describes the method of encapsulating a new series of electronic devices developed by the Naval Ordnance laboratory. Using silicones helps to provide the utmost protection against mechanical and thermal shock, vibration, and humidity. *No. 29*

Documentary film "What's a Silicone?" available free of charge for showing to technical audiences. For more information circle *No. 30*

Waterproof Wire Splice With Silicone Compound

The sales success of "Super-Splice", designed by Superior Cable Corporation, Hickory, N. C., testifies to the superior dielectric properties of Dow Corning silicone compound. Over 2,000,000 of the splices have been sold in the last two years.

Originally developed for telephone cable work, the "Super-Splice" is a simple polyethylene sleeve sealed at one end and filled with grease-like Dow Corning silicone compound. It is quickly and easily slipped over twisted pigtails to form a splice that retains optimum electrical insulating properties despite prolonged exposure to moisture.

Extensive laboratory tests have proved that "Super-Splice" retains its full insulating effectiveness even after a full year under water. During these tests, splices featuring polyethylene-insulated wire protected with silicone-filled "Super-Splice" withstood 45,000 volts dc and measured 200,000 megohms insulation resistance while immersed in water.

Since the silicone compound does not harden with aging, the insulator may be removed at any time to facilitate maintenance. "Super-Splices" now available are 2⅛" long and are suitable for straight, butt or bridge splices of 19, 22 or 24 gauge wire. *No. 31*

Send Coupon for More Information

DOW CORNING CORPORATION - Dept. 4108
Midland, Michigan
Please send me 27 28 29 30 31

NAME _____
TITLE _____
COMPANY _____
STREET _____
CITY _____ ZONE ____ STATE _____

ATLANTA • BOSTON • CHICAGO • CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEW YORK • WASHINGTON, D. C. (Silver Spring, Md.)
Canada: Dow Corning Silicones Ltd., Toronto; **Great Britain:** Midland Silicones Ltd., London; **France:** St. Gobain, Paris

For more information circle 55 on reader service card.

1. You'd want positive protection. General Electric gives it to you with two precision tripping actions—thermal and independent magnetic. You get double-barreled protection against short circuits and sustained overloads.

2. Wouldn't you demand the utmost safety to guard personnel? G.E. makes sure that the handle can't hold the contacts closed during a short circuit. The breaker can be switched by hand at currents even up to the full interrupting rating.

If you were writing the specs for your own circuit breaker installations, you'd insist on these four performance features

GENERAL ELECTRIC HAS ALREADY BUILT THEM IN!

3. Dependability? You'd insist on years of it! Quick-make, quick-break action prevents burning of contacts and lengthens breaker life. General Electric's de-ionizing arc quenchers assure efficient interruption and rapid cooling of arcs.

4. Naturally, you'd want fast installation, low-cost maintenance. G.E. accomplishes it with solderless lugs, straight-in wiring and positive trip indication. And there are no fuses to stock and replace; fast restoration of service boosts production.

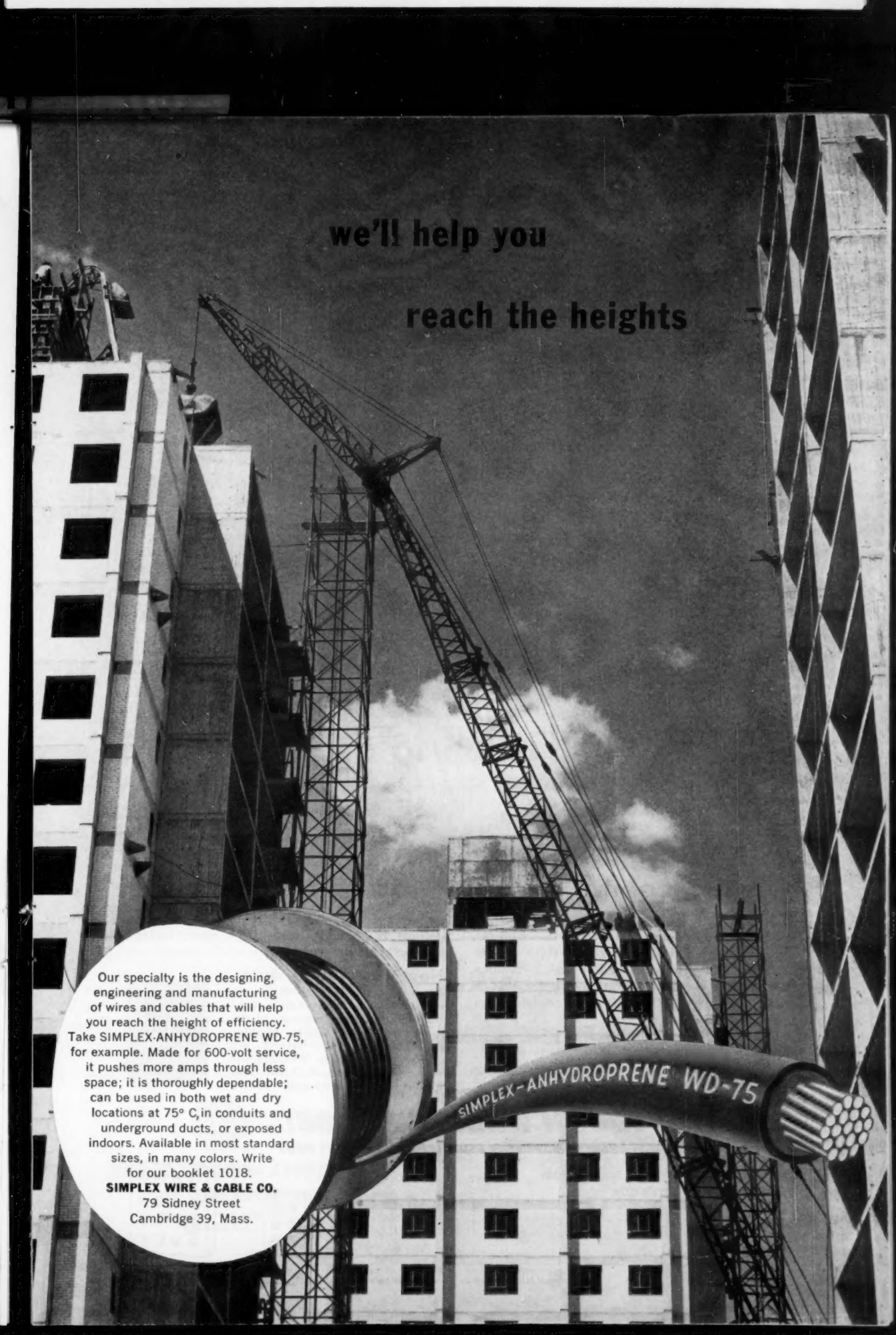
Finally, you'd specify a line to handle every low-voltage requirement (up to 600 volts, 800 amps), with a wide selection of accessories and a choice of separate enclosures. In fact, you'd ask for a line of General Electric molded case circuit breakers—available from your nearby G-E distributor. *General Electric Company, Circuit Protective Devices Department, Plainville, Connecticut.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

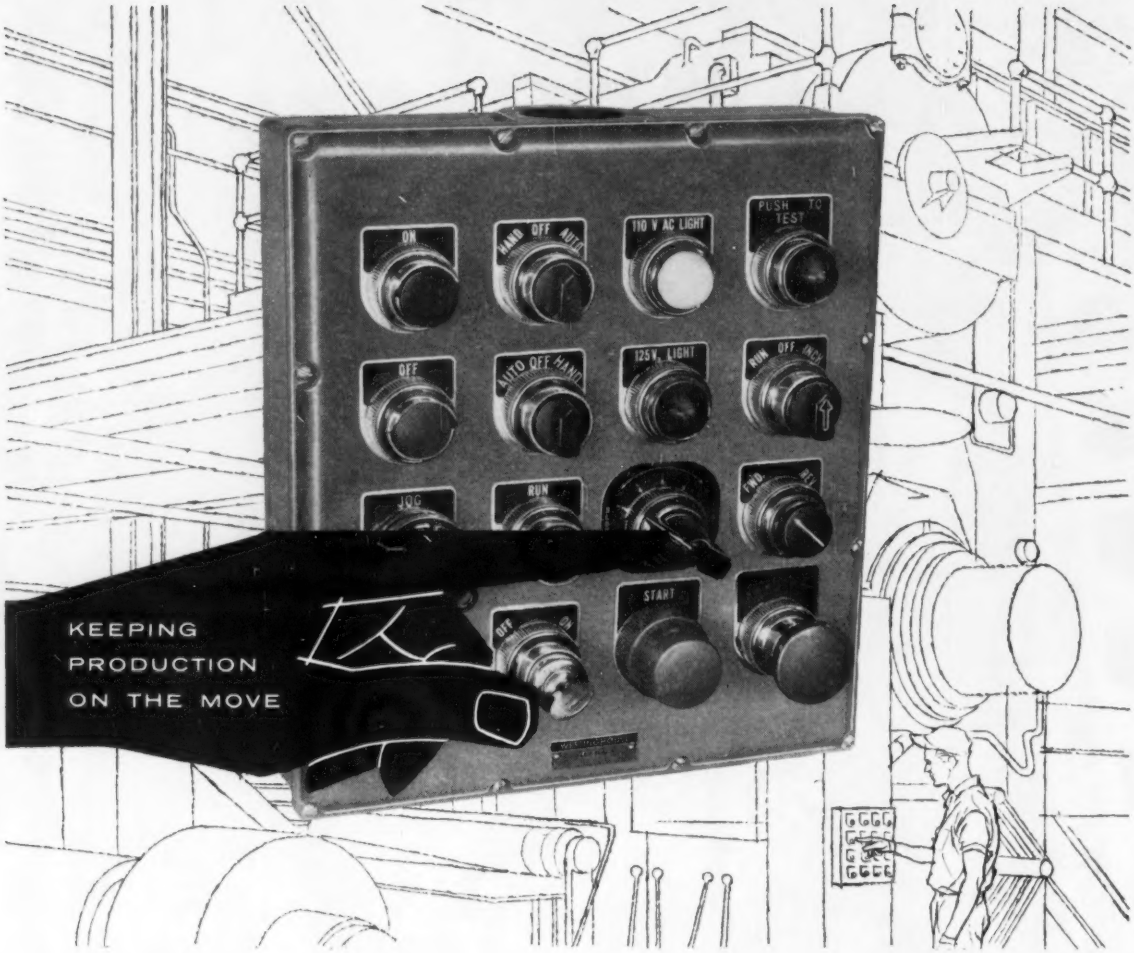
For more information circle 56 on reader service card.

Circle 57 on the card. ▶



Our specialty is the designing, engineering and manufacturing of wires and cables that will help you reach the height of efficiency. Take SIMPLEX-ANHYDROPRENE WD-75, for example. Made for 600-volt service, it pushes more amps through less space; it is thoroughly dependable; can be used in both wet and dry locations at 75° C, in conduits and underground ducts, or exposed indoors. Available in most standard sizes, in many colors. Write for our booklet 1018.

SIMPLEX WIRE & CABLE CO.
79 Sidney Street
Cambridge 39, Mass.



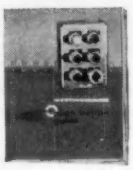
. . . with Westinghouse Oil-Tite control stations—1 to 16 units

Interchangeable parts — stations, contact blocks, operators and indicating lights — right off the shelf, quickly give you a "tailor-made" Westinghouse Oil-Tite* control station to meet the requirements of any heavy-duty industrial equipment application.

Enclosures — die-cast and Bonderized — include cork-neoprene gasketing and close machine fits as positive seals against exposure to oil, coolants, cutting compounds, water and other foreign matter.

*Trade-Mark

New Pushbutton Guide



For more facts on why it will pay you to standardize with Westinghouse control stations, get a free copy of the new *Pushbutton Guide*, booklet B-6749. See your nearby Westinghouse salesman or write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-30210

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING FOR **YOU!***

THERE'S A WESTINGHOUSE PUSHBUTTON TO MEET EVERY APPLICATION NEED!

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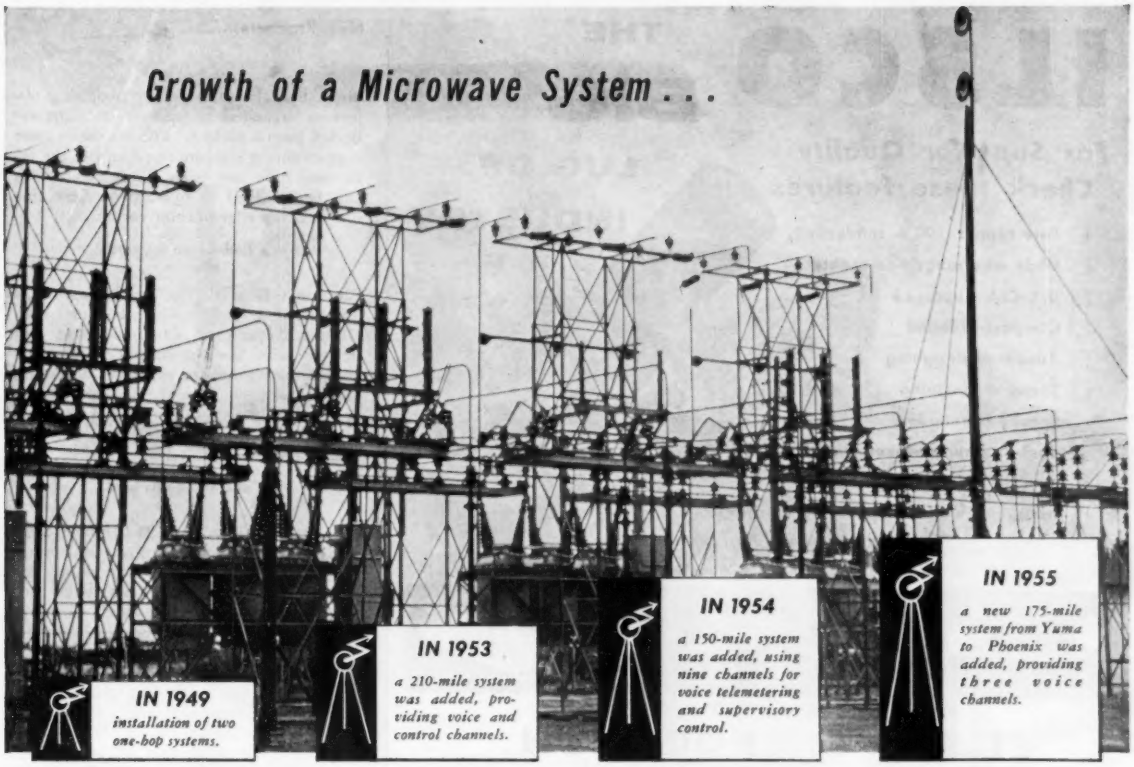
Growth of a Microwave System . . .
IN 1949
installation of two one-hop systems.
IN 1953
a 210-mile system was added, providing voice and control channels.
IN 1954
a 150-mile system was added, using nine channels for voice telemetering and supervisory control.
IN 1955
a new 175-mile system from Yuma to Phoenix was added, providing three voice channels.

They Chose RCA Microwave Every Time Because of Its DEPENDABILITY

. . . for growing multi-station system at Arizona Public Service Co.

The original installation at Arizona Public Service Company in 1949 consisted of two RCA one-hop systems used to control unattended substations from the central steam-electric plant at Phoenix. Additional RCA systems were installed in 1953 and 1954, and again in 1955.

This steady growth with RCA Microwave—to the present multi-hop system—attests to its proven performance under the most trying conditions . . . including ambient 140 degree heat, high winds, severe electric and dust storms and violent rains.

Here also is proof of its ease of adaptability to future requirements. Through the years the dependability of this equipment has been virtually 100%. Completely independent of the transmission lines it services, it provides unfailing communications and control when needed most.

You can be sure of your microwave system's dependability if you first seek the advice of microwave engineers at RCA . . . world leader in radio and electronics. RCA equipment uses easy-to-service, familiar circuits and readily available tubes. It can interconnect with existing telephone lines, switchboards and mobile radio installations. Only RCA Microwave systems provide so many advanced engineering features. Get complete data.

RCA Microwave Specialists will be glad to answer any questions and help plan your installation. Mail coupon for further particulars on use of Microwave in utilities, pipelines, turnpike and other applications.

RCA MICROWAVE

POINT-TO-POINT COMMUNICATION

Performance proved in more than a million channel miles of operating systems throughout the world.

RADIO CORPORATION of AMERICA
COMMUNICATIONS PRODUCTS
CAMDEN, N. J.

Radio Corporation of America
Communications Products, Dept. H-42, Building 15-1, Camden, N. J.

☐ Please send me latest literature on RCA Microwave.

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

☐ Have an RCA representative get in touch with me.

For more information circle 59 on reader service card.

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√ Check these features

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- ☐ Sound engineering
- ☐ Speedy installation
- ☐ Cool operation—takes overload
- ☐ No special tools needed
- ☐ All screws wax-treated for better clamping

ALL THESE FEATURES AT LOW COST

Your √ Test Will Prove ILSCO Superiority Over Cast Or Any Other Type Lugs

Write for Catalog #50 and Samples

ILSCO CORPORATION

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▲ Circle 60 on the card.

If you are a

TOP NOTCH RELIABILITY ENGINEER

please answer these questions:

(1) Have you an inquisitive mind?

(2) Do you respond to professional challenge?

(3) Is personal recognition important to you?

(4) Doesn't the current work on Missile Systems Reliability impress you as one of the most fruitful fields in engineering today—in scope, in equipment available, in talents engaged?

(5) Isn't North American Aviation's Missile Engineering staff the place for YOU—where your electrical, electronic, mechanical or aeronautical ability can be stimulated to optimum performance?

Your immediate, positive reaction to these questions can start you toward a position of authority in this field. Join this group and share in its successes. Write: R. L. Cunningham, Missile Development Engineering Personnel, Dept. 991-20EE

NORTH AMERICAN AVIATION, INC.

12214 Lakewood Boulevard, Downey, Calif.

New Products

(*Continued from page 42A*)

direct light beam is cut by a passing object or arranged to operate on light reflected from a surface. For extremely close registration, a self-contained unit of the reflecting type has been developed. This can be targeted to operate on very fine line or sharp edge of color variation.

▲ Item 61 on the card.

Channel Duct. The replacement of hand-formed solid wire layouts with Glastic Corporation Channel Duct and flexible wire greatly simplifies assembly and wiring, eliminates expensive harnesses, allows layout changes at will, and simplifies maintenance. This product is resistant to warpage during and after assembly, and also is flame resistant.

▲ Item 62 on the card.

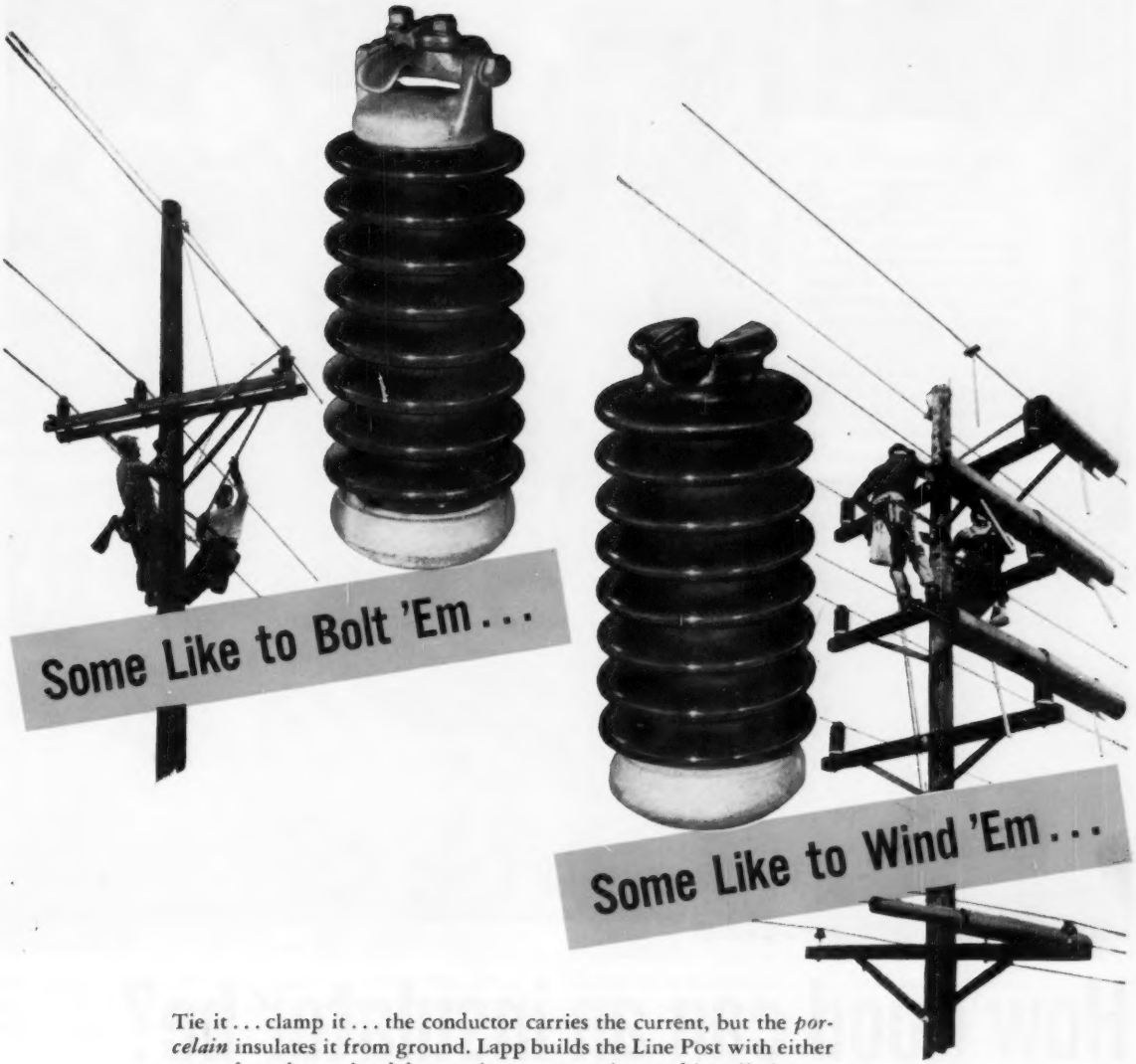
Magnetically Regulated D-C Power Supply. The availability of a dual magnetically regulated d-c power supply for laboratory and industry has been announced by Magnetic Research Corporation. Designated the Stablvolt model *MR 532-15*, the unit is short-circuitproof, has excellent static and dynamic regulation, and provides line transient-free d-c power. Offering an output range of 3 to 36 volts at 15 amps, the Stablvolt *MR 532-15* features static regulation of ±0.25 per cent, ripple less than 50 millivolts for the entire voltage range, dynamic regulation of less than 1 per cent for a 10 per cent line transient, and less than 1.5 volt for a 10 per cent load transient. Response time is less than 25 milliseconds for line transients and 150 milliseconds maximum for load transients. Voltage adjustment is accomplished by a potentiometer. No tubes or variacs are incorporated in the unit. When short-circuited, line current is automatically limited, protecting power supply from internal damage. Normal operation is resumed automatically. There is no fusing, resetting of switches, or maintenance time.

▲ Item 63 on the card.

Slimmest Room Air Conditioner. "The Slimline" air conditioner, measuring only 15 inches deep with a flush-mount design that eliminates unsightly overhang inside or outside the room has been introduced by Emerson Radio and Phonograph Corporation. In addition to its compact design, there are other specific advantages for builders. A builder can now install air conditioners in one room or every room without the high cost of a central power plant and air ducts. Individual units, as contrasted with a central system, allow each user to determine his own room temperature level. The units also preclude the possibility of complete breakdowns of air conditioning service throughout the building inasmuch as individual units can be repaired on an individual basis. Slimline air conditioners are available in 1/2-, 3/4-, and 1-hp units.

▲ Item 64 on the card.

(*Continued on page 76A*)



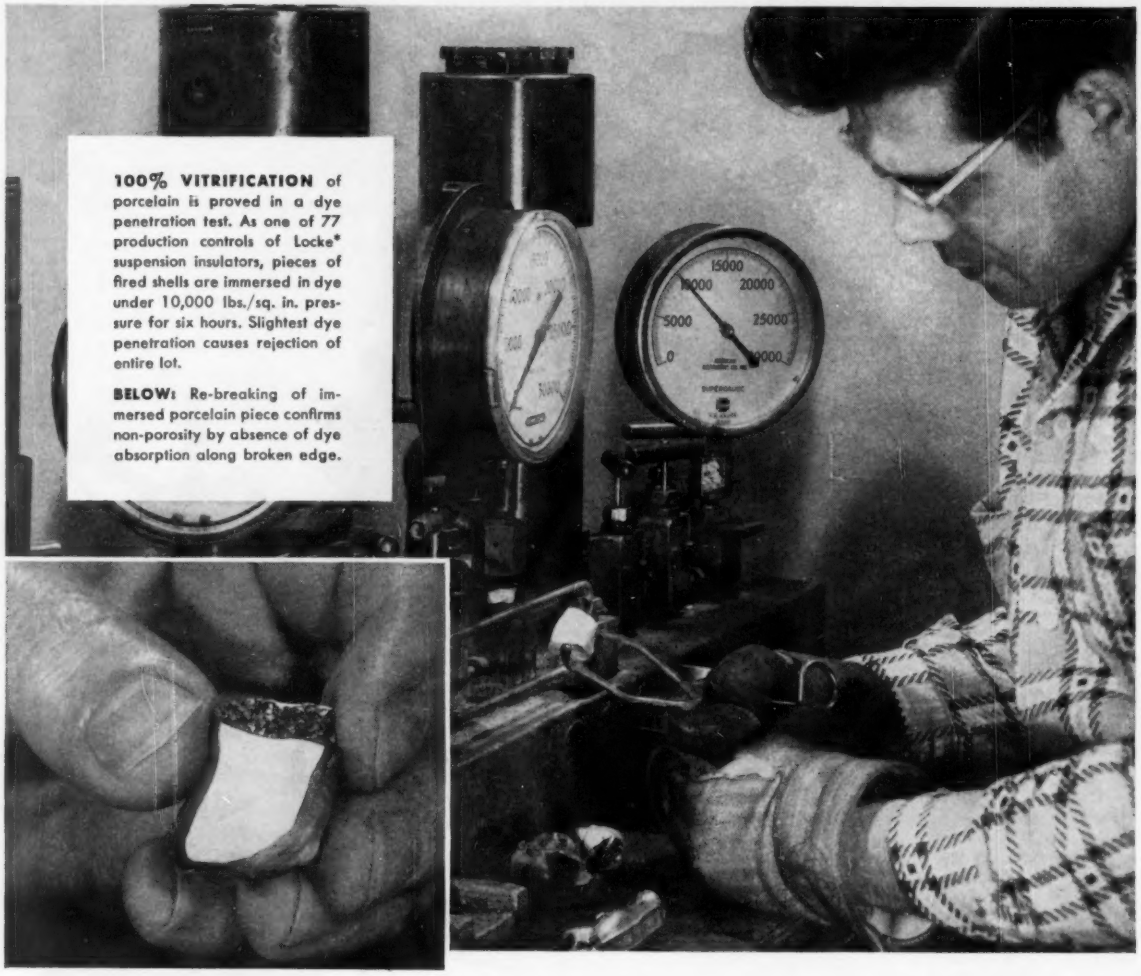
Tie it . . . clamp it . . . the conductor carries the current, but the *porcelain* insulates it from ground. Lapp builds the Line Post with either type of conductor head for maximum convenience of installation . . . and it builds the *porcelain* to do the *insulating* job. The porcelain in either case is a closed-end post, of high density vacuum-process electrical porcelain. It won't puncture because it has no conductive material within it. It outperforms any other type of insulator in dirt conditions because its fog-type design prevents leakage flashover from non-uniform leakage resistance. It stands up under arcover, stones and bullets because its short, sturdy petticoats protect the body. And it won't crack because its hardware, both top and bottom, is *externally* attached, and can load porcelain only in compression.

With tie-wire or clamp-top, the Lapp Line Post will give you an *extra* margin of operating security, low upkeep, long life.

Lapp Insulator Co., Inc., Le Roy, N. Y.

Lapp

For more information circle 65 on reader service card.



100% VITRIFICATION of porcelain is proved in a dye penetration test. As one of 77 production controls of Locke* suspension insulators, pieces of fired shells are immersed in dye under 10,000 lbs./sq. in. pressure for six hours. Slightest dye penetration causes rejection of entire lot.

BELOW: Re-breaking of immersed porcelain piece confirms non-porosity by absence of dye absorption along broken edge.

How good can an insulator be?

CONSIDER THESE TESTS OF

Satisfactory micro-structure of the fired insulator shell, assuring mechanical and electrical soundness, is an absolute *must* before it is allowed to become part of an insulator for your lines.

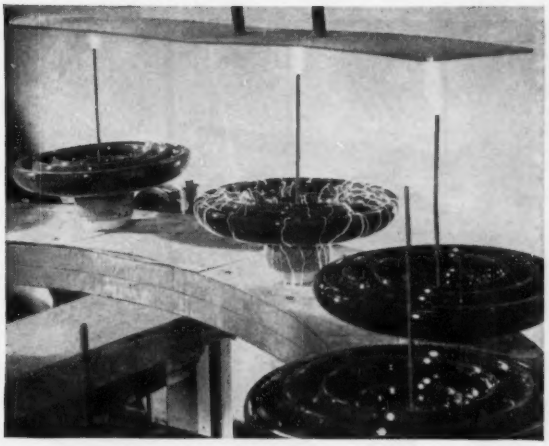
While the completed porcelain may appear solid, smooth and uniform at an outward glance, only close microscopic examination and other tests can prove it homogeneous, non-porous and properly glazed. Porcelain must be completely vitrified. For satisfactory composition, density must be uniform and within narrow limits.

Glaze must be of prescribed thickness to obtain maximum mechanical strength. The procedures shown above are individually scheduled as dictated by sound engineering judgment. They are your assurance of the dependability of each Locke insulator.

The case of Fired Porcelain "Quality Control" is typical of the extremes to which General Electric goes to assure trouble-free service on your system.

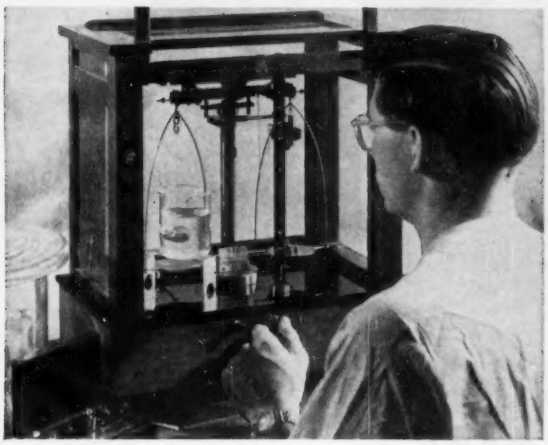
For a brief and complete picture story of insulator quality control, simply ask your General Electric Insulator representative or write to Insulator Department, General Electric Company, P. O. Box 57, Baltimore, Maryland.

For more information circle 66 on reader service card.



FIRST ELECTRICAL TEST of porcelain shells follows firing. Moving on a conveyor, they must withstand a 3- to 5-second flashover test at about 200 kilocycles without puncture.

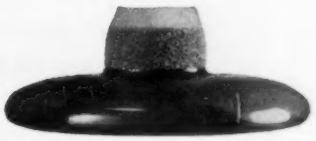
EXACT GLAZE THICKNESS, vital to the mechanical and electrical strength of the finished MICROGLAZE* insulator, is accurately determined by microscopic measurement.



FIRED DENSITY TEST—As the specific gravity of properly vitrified porcelain falls within a very narrow range, it is possible through this test to detect very small deviations from satisfactory composition.

TISSUE THIN PORCELAIN sections, when examined through a petrographic microscope, reveal their crystalline structure and state of maturity.

FIRED PORCELAIN



Progress Is Our Most Important Product

GENERAL ELECTRIC

*Trademark of General Electric Company

ROCKBESTOS A.V.C.®

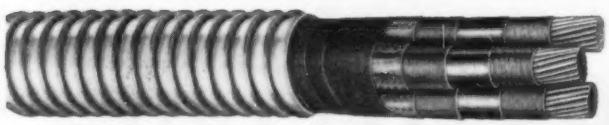
(N.E.C. TYPE AVA)

INTERLOCKED ARMORED CABLE

FOR **New Buildings**
Expanding Existing Circuits
Relocating Old Circuits

Rockbestos A.V.C. Interlocked Armored Cable gives you more current capacity than cable in conduit or other armored cable . . . is easily installed on racks or hangers beneath the ceiling or next to walls . . . can be installed up, down or around walls, beams or posts. It eliminates costly conduit and ducts . . . saves dollars on these materials . . . easier to install . . . cuts installation time . . . permits quick easy repairs.

Write for the new manual which gives application and design data for Rockbestos A.V.C. Interlocked Armored Cable.



ROCKBESTOS PRODUCTS CORPORATION
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Circle 68 on the card. ▶

let OHMITE engineers "TEAM UP" with your engineers

IN SOLVING YOUR RESISTANCE PROBLEMS

Save valuable engineering time . . . team up with Ohmite to solve your resistance problems. Ohmite engineers are resistance specialists . . . they can quickly analyze your requirements and recommend the correct rheostats and resistors to fit your application. Years of experience in building dependable resistance units . . . complete design, development and production facilities . . . plus a long record of helping others to economically solve their resistance problems . . . are your assurance that Ohmite can help you. We invite you to submit your resistance problems to us.

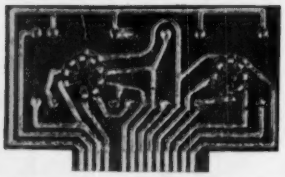
OHMITE MANUFACTURING COMPANY, 3614 Howard Street, Skokie, Illinois (Suburb of Chicago)

Be Right with - OHMITE®

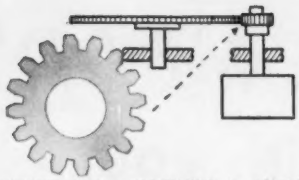
RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES • TANTALUM CAPACITORS

glass-base laminates?

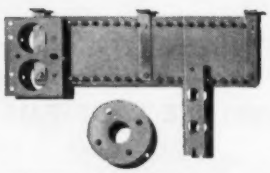
C-D-F DILECTO®
is the answer!



SPEED AUTOMATIC PRODUCTION of printed circuits with warp-resistant C-D-F metal-clad Teflon* and epoxy laminates. Other advantages: high bond strength of copper to laminate, superior blister-resistance in solder immersion.



HIGH-VOLTAGE (1800v.) RF ISOLATION is achieved by miniature C-D-F Dilecto gears in an aircraft receiver-transmitter switch. They also had to exhibit dimensional stability through a wide temperature range, resistance to fungus growth and thermal shock.



PRECISE MACHINING AND FABRICATION are standard benefits of Dilecto laminated plastics. These silicone glass-base parts (coil mountings, aircraft terminal board) were sawed, drilled, punched, and milled in production quantities by C-D-F and customer.

Teflon*, silicone, epoxy, melamine, phenolic, polyester resins laminated with glass-fiber cloth

You can improve design, speed production, and save money by specifying one of the many C-D-F Dilecto grades. Whatever your application for these laminates — with fine- or medium-weave glass-cloth base — you'll find a better answer to your problem at C-D-F. (Melamine and polyester can also be made with glass-mat base.) And C-D-F offers modern machining and fabrication facilities to deliver production quantities of finished Dilecto parts to your specifications.

See our catalog in Sweet's Product Design File, where the phone number of your nearby C-D-F sales engineer is listed. For free trial samples of glass-base Dilecto, or of any other C-D-F plastics, mica, or fibre product, send us your print or your problem! Write for your free copy of C-D-F Technical Bulletin 64.

PROPERTIES OF SOME TYPICAL C-D-F DILECTO GLASS-BASE GRADES

Grade	Equivalent NEMA or ASTM grade	Flexural Strength Lengthwise (PSI)	Dissipation Factor at 10^6 ~ Cond. D24/23	Dielectric Strength Parallel Step x step	Insulation Resistance Cond. C96/35/90	Arc Resistance (seconds)	Maximum Operating Temp. (°C.)
GB-116T (Teflon*)	None	14,000	0.001	65	100,000	180+	250
GB-12S (Silicone)	G-7	30,000	0.008	60	100,000	245	200
GB-181E (Epoxy)	G-10	75,000	0.020	75	20,000	120	165
GB-28M (Melamine)	G-5	48,000	0.025	50	100	185	150
GB-261D (Phenolic)	G-1 and G-2	22,000	0.060	55	10,000	5	150
GM-PE (Polyester)	GPO-1	35,000	0.060	60	5,000	145	150

These are typical grades for typical applications. To meet special requirements, C-D-F makes many other Dilecto grades, one of which may serve your purpose better than any of these listed here. Consult the C-D-F Technical Department for expert assistance with your design problem involving laminated plastics products.

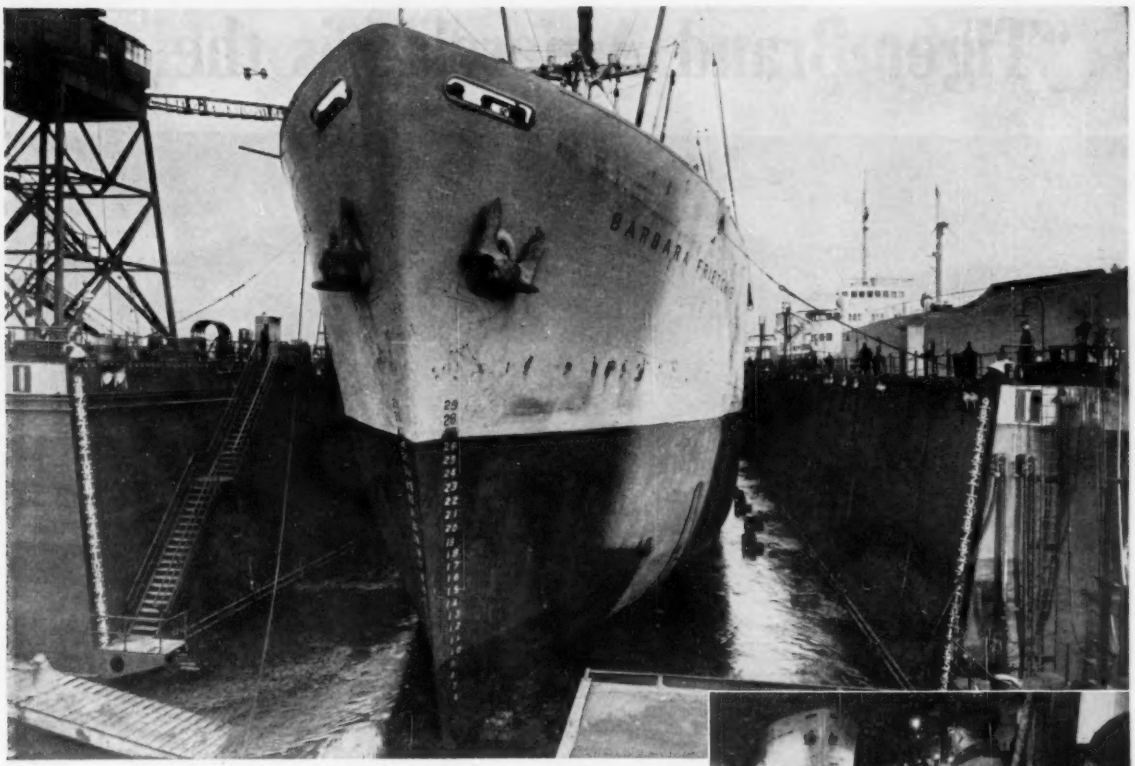
*DUPONT TRADEMARK FOR TETRAFLUOROETHYLENE RESIN

CDF **CONTINENTAL DIAMOND FIBRE**

CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.

NEWARK 86, DELAWARE

For more information circle 69 on reader service card.



CLARK provides Push Button Control of Ships in Drydock

One man at the Clark Master Control Station controls the pumps that regulate water level in each of 18 separate compartments in the bottom of this modern dry dock in Hoboken, New Jersey. Instructions to operator and dock crew are given over a loudspeaker by the dockmaster seen outside the window in the small photograph at the right. Lower illustration shows one of the Clark Control Centers at the side of the dry dock housing controls for pumps and winches which accurately position the ship.

Clark engineered control systems are performing a wide range of vital functions in all kinds of industry. If you have a control problem, let us help you solve it.

Clark Master Control station controls pumps that regulate water level in 18 watertight compartments.

One of the Clark Control Centers housing controls for accurate positioning of ships.

The CLARK CONTROLLER Company

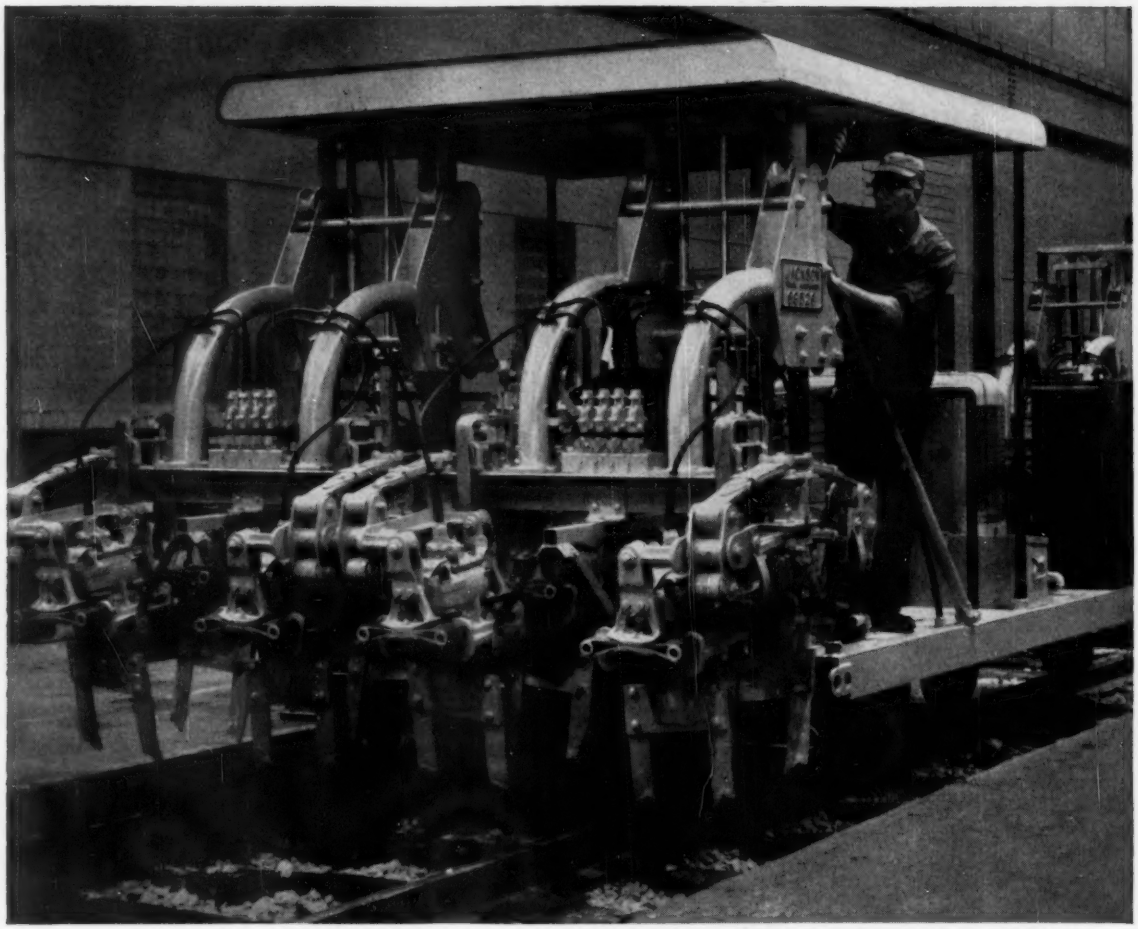
Engineered Electrical Control

1146 East 152nd Street • • Cleveland 10, Ohio

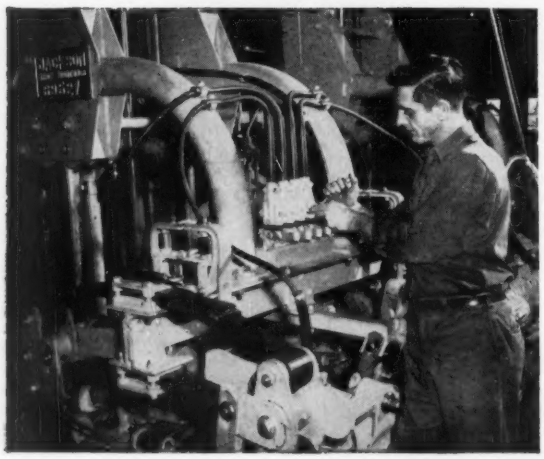
IN CANADA...CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

For more information circle 70 on reader service card.

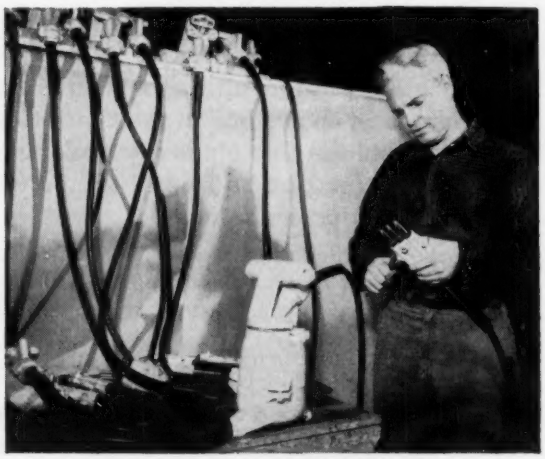
"Tiger Brand Amerclad is the most



The completely self-contained Jackson Track Maintainer.



Tightening connectors. Machine delivers 4500. 2-ton blows per minute.



Assembling leads. Each vibrator delivers ¼ ton blow.

For more information circle 71 on reader service card.

durable cable we've ever used"

says **ELECTRIC TAMPER & EQUIPMENT CO., Ludington, Michigan**

MANY years ago, the executives at Electric Tamper & Equipment Co. found out that when railroads order a piece of machinery, they expect it to last a long time—without breakdowns. Since then, Electric Tamper has won a high place in industry by producing a line of the hardest-working, *toughest* track maintenance machines on the market.

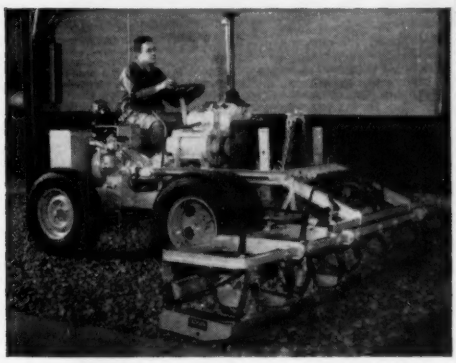
Leader of the line is the Jackson Track Maintainer, used for tamping ties. It has 8 powerful vibratory motors that drive 8 tamping assemblies. Each motor is powered with Tiger Brand Amerclad cable. The vibration and flexing (which are very severe) caused previous cable to crack until the jackets actually peeled away from the conductors. So they asked American Steel & Wire for advice.

Tiger Brand Amerclad was the solution. Finely stranded conductors soak up vibration and allow greater flexibility than ever before. The tough, well-cured jackets are impervious to oil, grease and the burning sun.

In the company's own words, "Tiger Brand cable is certainly superior to anything we have ever seen for this class of service. Its complete dependability under all service conditions has definitely helped us to maintain our good reputation in the field."

Do you want a *better* electrical cable—engineered for your equipment? Just call your American Steel & Wire representative.

The Jackson Multiple Compactor for consolidation of granular soil.



Hand Vibrospade. Cable usually drags on the ground.

Small compactor. See why they need durable cable?

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL, GENERAL OFFICES: CLEVELAND, OHIO

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS TIGER BRAND ELECTRICAL WIRE & CABLE

A STANDARD TIGER BRAND CABLE FOR EVERY SPECIAL JOB

- machine tool and building wire
- special purpose wire and cable
- asbestos wire and cable
- paper and varnished cambric cable
- aerial, underground and submarine cable
- shovel and dredge cable
- mold cured portable cord

UNITED STATES STEEL

Another new development using

B.F.Goodrich Chemical *raw materials*

This plastic sleeve was developed by Steere Enterprises, Akron, Ohio, in cooperation with The Cleveland Electric Illuminating Company.

"PANTS LEG" INSULATOR MADE FROM GEON

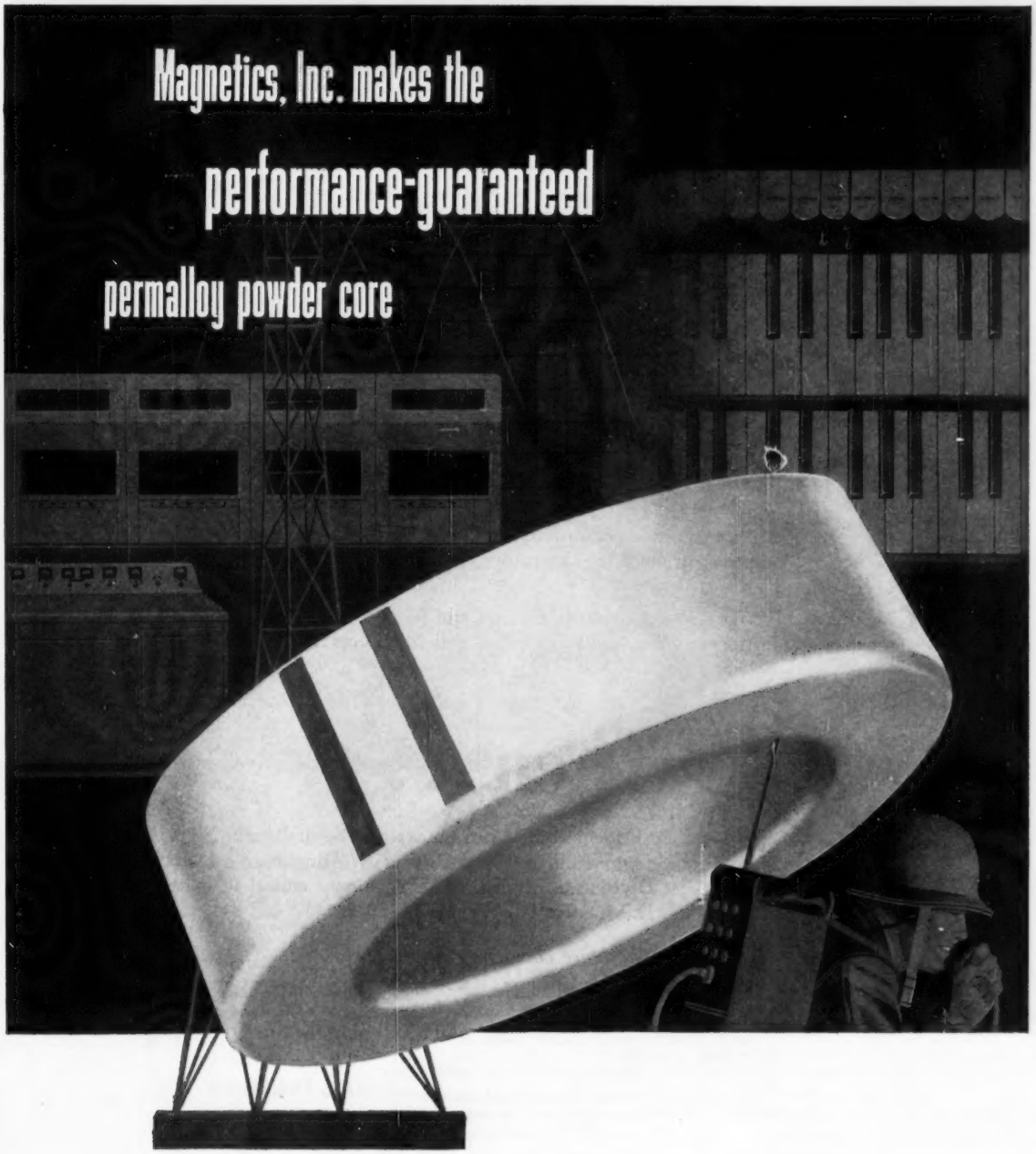
does something about the weather... and time

A NEW Geon polyvinyl plastic sleeve for lead-in wire terminal connections on outdoor potheads installs quicker, lasts longer and gives better protection from weather and flashover caused by moisture. The chemical, physical and electrical properties of Geon make it the ideal material for this job.

The sleeve is dip-molded from a plastisol based on Geon resin. The two ends of wire are led into the two pants legs (see inset) and spliced together in the opening in the body of the cover. The cover is then closed and sealed with electrical tape—using far less tape than with ordinary connections. From there on it's a test of time.

Geon resists the effects of changing weather—at the same time maintaining its high dielectric qualities. It further protects against fire, chemical action and abrasion. The combination of properties of Geon resin makes it a material for every designer to know. For further information on how Geon may fit your needs, write Dept. DH-4, B. F. Goodrich Chemical Company, Rose Bldg., Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

B.F.Goodrich GEON polyvinyl materials • HYCAR American rubber and latex • GOOD-RITE chemicals and plasticizers • HARMON colors



We have taken the guesswork out of using molybdenum permalloy*powder cores, for Magnetics, Inc. Powder Cores are Performance-Guaranteed. What's more you can specify as an extra, Magnetics' exclusive feature . . . color-coding. Color-coding *tells* your assemblers, *without special testing*, how many turns to put on these cores, for they are graded and coded according to inductance before they reach you.

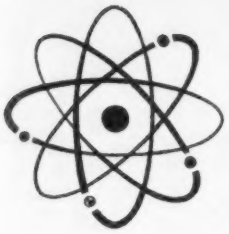
Bulletin PC-103 gives you detailed information, and the Powder Core Color-Coding Card guides your assemblers and others with production responsibility. Why not write for your copies today? Magnetics, Inc., Dept. EN-30, Butler, Pennsylvania. *Manufactured under a license with Western Electric Co.

MAGNETICS inc.

CABLE: Magnetics

For more information circle 73 on reader service card.

ENGINEERS · PHYSICISTS



Do YOU Want?...

Freedom in thinking and the practice of development engineering, with a minimun of supervision?

Complete, *modern*, development laboratory facilities?

Association with a company whose background in electronic tubes dates to the earliest days of vacuum tubes?

To work in a company whose position in industry can weather economic stresses?

To live in a fine community of lovely residential areas, within minutes' drive of the laboratory, where all summer and winter sports are nearby?

To have an opportunity for you *and your family* to grow and prosper in a fine small city with excellent schools and churches?

Then...

You will want to further explore the challenging electronic tube engineering opportunities at Westinghouse Electronic Tube Division in Elmira, N. Y. Telephone collect or send resumé to R. M. Jarrett (Phone Elmira 9-3611).

There are challenges in such fields as:

TUBE DESIGN & DEVELOPMENT
MICROWAVE TUBES: Magnetrons, traveling wave tubes, klystrons, reference cavities, and other devices.
PICKUP DEVICES: Image orthicon, vidicon, infra-red, X-ray image intensifier.
POWER TUBES: High power, neutron counter, or gas tubes.
CATHODE RAY TUBES: Color and black-and-white.
OTHER TUBES: Including receiving and power tubes.

THERMIONIC EMISSION ENGINEERING
In each aforementioned field.

APPLICATION ENGINEERING
In each aforementioned field.

GLASS ENGINEERING
For power tube manufacturing.

Perhaps you are planning an August or early September vacation, and can visit us in Elmira. Please phone prior to visit for appointment for personal interview, and bring resumé and pertinent details. Telephone now, collect, to R. M. Jarrett (Elmira 9-3611) for a definite date for your visit.

ONLY YOU! CAN MAKE THIS IMPORTANT DECISION Write Now!

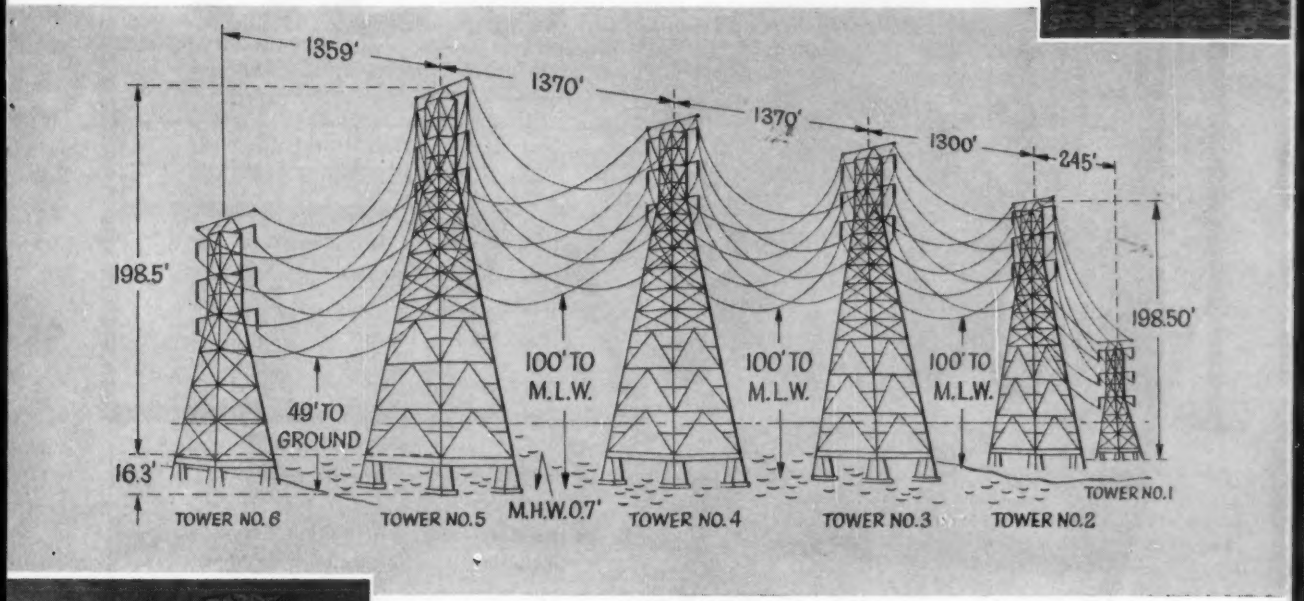
Send resumé, or telephone collect, to R. M. Jarrett, Dept. L 20

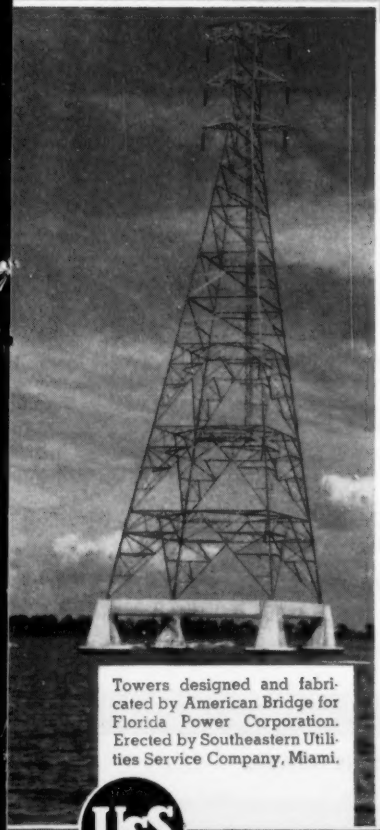
Westinghouse
ELECTRONIC TUBE DIVISION • ELMIRA, NEW YORK

WESTINGHOUSE

Circle 74 on the card. ▶

LIGHTWEIGHT Steel Towers *by* **AMERICAN BRIDGE** *save Florida Power Corporation $7,200 in erection costs!*





Towers designed and fabricated by American Bridge for Florida Power Corporation. Erected by Southeastern Utilities Service Company, Miami.

. . . The three towers in the bay are each 6½ tons lighter, but they are designed to withstand hurricane-force winds of 135 mph!

When the Florida Power Corporation planned its transmission line crossing Old Tampa Bay, water traffic requirements dictated that the towers would have to be tall enough to suspend lines no lower than 100′ from Mean Low Water level. After computing the sag of the lines and the suspension required, it was determined that four of the towers (numbers 2, 3, 4 and 5 in the diagram above) would have to be 198′ 5″ high. This was not too much of a problem. However, the location demanded that the towers be designed to resist hurricane-force winds of 135 mph with an overload capacity factor of 1.25.

To get the strength required and yet keep the towers as light as possible for ease of transportation and handling in that remote, inaccessible area, American Bridge used a high-strength steel (USS MAN-TEN) rather than plain carbon steel in the tower legs to reduce the weight of the four towers by 26 tons.

This reduction in the weight of the four towers resulted in a savings of $7,200 in erection costs.

American Bridge towers are made to order for every type of transmission line service. They are designed for simplified erection over water; on level, side-hill, or rocky butte sites. They are engineered for heavy-duty service under the severest climatic conditions. For recommendations based on your particular requirements, just contact our nearest office.

AMERICAN BRIDGE DIVISION, UNITED STATES STEEL CORPORATION
GENERAL OFFICES: 525 WILLIAM PENN PLACE, PITTSBURGH, PA.

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USS

UNITED STATES STEEL

THE *New* CHAMPION 350

Not just another low-frequency cathode-ray oscillograph but a decidedly grown up instrument combining the best features of the laboratory standards by Du Mont which have gone before it. All these features and more:

- **Exceptional stability—all voltages regulated**
- **No drift—less than 10 mv in 8 hrs. including 10% line voltage changes**
- **Identical X- and Y-amplifiers**
- **Amplitude calibration on both axes**
- **Accurate X-Y plotting at frequencies from d.c. to 150 kc.**
- **Ideal for precise phase shift measurements—less than 1° relative phase shift below 150 kc.**
- **Superior sweep linearity with hard-tube circuit**
- **Automatic beam brightening on sweeps**
- **Automatic beam brightening for transient plots**
- **High brightness—3KV acceleration**
- **Provision for very slow sweep rates**

CONDENSED SPECIFICATIONS:

VERTICAL DEFLECTION: *sinusoidal response,* flat to d.c., down not more than 30% at 150 kc; *deflection factor,* 20 p-p mv/inch.

HORIZONTAL DEFLECTION: identical to vertical axis except *deflection factor,* 25 p-p mv/inch (due to higher deflection factor of horizontal deflection plates).

SWEEPS: *mode,* driven or recurrent; *frequency,* 2 cps to 30 kc; *beam gate,* automatic during forward sweep.

AMPLITUDE MEASUREMENT: (both X and Y axes) *range,* 0.1, 1, 10 and 100 volts full scale; accuracy, ±5%.

PHASE SHIFT: *amplitude controls at max.,* less than 1° below 150 kc.

PRICE ONLY **$395**

IMMEDIATE DELIVERY!

Write for complete specifications

DU MONT ALLEN B. DU MONT LABORATORIES, INC., 760 Bloomfield Ave., Clifton, N. J.

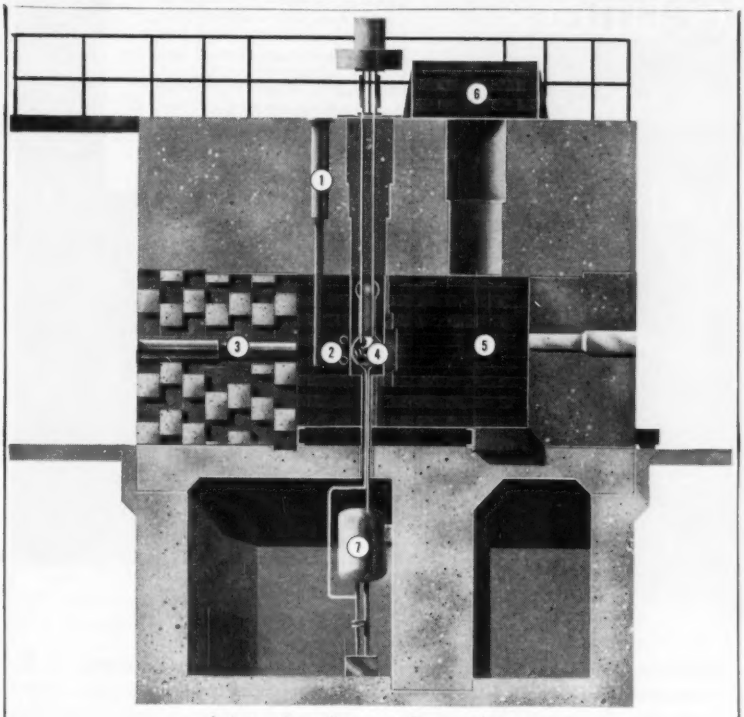
DON'T MISS THE DU MONT INSTRUMENT EXHIBIT AT WESCON BOOTHS 939-940

For more information circle 75 on reader service card.

NUCLEAR NEWS FROM ATOMICS INTERNATIONAL

Aqueous, homogeneous type nuclear reactor being built for Japan

The first nuclear reactor for the Far East is being built by ATOMICS INTERNATIONAL for the Atomic Energy Research Institute of Japan. The reactor will be located near Tokyo. When the reactor starts operating early in 1957, a full program of research into the peaceful applications of nuclear energy will begin. This program includes the production of radioisotopes, studies in neutron activation, neutron diffraction, radiation effect on materials and training in reactor techniques.



Solution Type Research Reactor for Japan.

1 – Vertical thimble
2 – Pneumatic tubes
3 – Beam Tubes
4 – Central exposure facility
5 – Horizontal thermal column
6 – Vertical thermal column
7 – Gamma radiation area

At a rated power of 50 kilowatts, this solution type reactor will produce a peak thermal neutron flux of 1.7 x 10^{12}/cm^2 sec. Equipped with a five foot graphite thermal column, it will provide an extensive source of slow neutrons. Additionally, the room beneath the reactor housing the gas handling system has been designed to provide neutron-free gamma irradiation. This facility, ideally suited for biological and chemical experiments, will provide 50,000 curies of radioactivity in Xenon and Krypton gases circulating in the system.

The core of the reactor is a stainless steel sphere with a diameter of approximately 12 inches, filled with a uranyl sulphate solution. The fuel investment is approximately 1000 grams of Uranium^{235}. The reflector around the core consists of graphite stacked in a rectangular steel tank 5 feet high, 5 feet wide and 8 feet long. Appropriate holes for experimental facilities and instrumentation are located in the graphite. Five feet of dense concrete provides a shield around the reflector tank.

Instrumentation control is provided by two types of sensing elements which give neutron level information. In the power range up to approximately 1 watt, two fission chambers are employed. In the power range of approximately 0.1 to 50,000 watts, two gamma compensated ionization chambers are used. One of these chambers is fed into a shutdown channel and an electrometer which in turn sends a signal to the power level recorder. Power level is automatically maintained by feeding an error signal from the level recorder to a servo-amplifier which drives the regulating rod motor in the proper direction to correct error. The other ionization chamber feeds a logarithmic amplifier, and period shutdown circuit.

The core cooling system consists of a closed, recirculating system using demineralized light water. The core cooling loop includes about 90 feet of stainless steel tubing, the associated pump, valves and piping, and a heat exchanger to transfer the heat to a secondary cooling system.

ATOMICS INTERNATIONAL, a division of North American Aviation, Inc., is a major reactor builder—experienced in the design, construction and operation of nuclear reactors for research and the production of power. A reactor similar to the one scheduled for Japan has been installed for the Armour Research Foundation of the Illinois Institute of Technology in Chicago. It is one of several in-action nuclear reactors designed and built by ATOMICS INTERNATIONAL.

If you are interested in any phase of reactor technology, ATOMICS INTERNATIONAL is staffed and equipped to serve you. Please write: Director of Technical Sales, Department EE-N4, ATOMICS INTERNATIONAL, P.O. Box 309, Canoga Park, California. Cable address: ATOMICS.

ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION, INC.
PIONEERS IN THE CREATIVE USE OF THE ATOM

In actual tests...

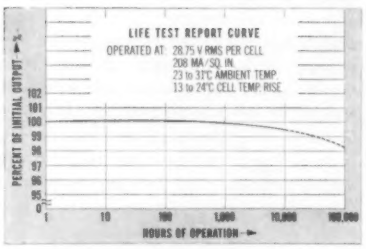
International Selenium Rectifiers

indicate life expectancy

of 100,000 hours!

RIQAP APPROVED

Manufactured under U.S. Army Signal Corps Reduced Inspection Quality Assurance Plan—RIQAP. International qualifies for this honor plan through years of constantly supplying products of high quality, equal to or better than the Accepted Quality Level established by the Government.



PERFORMANCE CHART

The chart above graphically demonstrates the life expectancy of International selenium power rectifiers. International manufactures a complete line of selenium and germanium power rectifiers, diodes, cartridges, photovoltaic cells—the widest range in the industry!

More than 40 individual tests conducted in International's Research Laboratories prove startling standards of life expectancy for your rectifier applications. International Selenium Rectifiers indicate continual operation for the equivalent of 12,500 working days—up to 100,000 hours!

This notable achievement is the result of creative imagination and productive skill used in International's Research and Development program. To assure the success of each project, all recognized methods of production have been incorporated in International's manufacturing facilities. In the production of selenium stacks, for example, *either* the pressed powder *or* the vacuum process can be used in accordance with the recommendations of the engineering department. Such versatility of production contributes to the most practical solution for your rectifier application.

76% of America's foremost rectifier users specify International. Under the U.S. Army Signal Corps Honor Inspection Program—RIQAP—countless thousands of rectifiers have been produced to provide answers to specific applications. If you have a rectification requirement or problem, write to the Application Advisory Dept. for an experienced and practical recommendation.

A WORLD OF DIFFERENCE ...THROUGH RESEARCH

International Rectifier

CORPORATION

EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA · PHONE OREGON 8-6281

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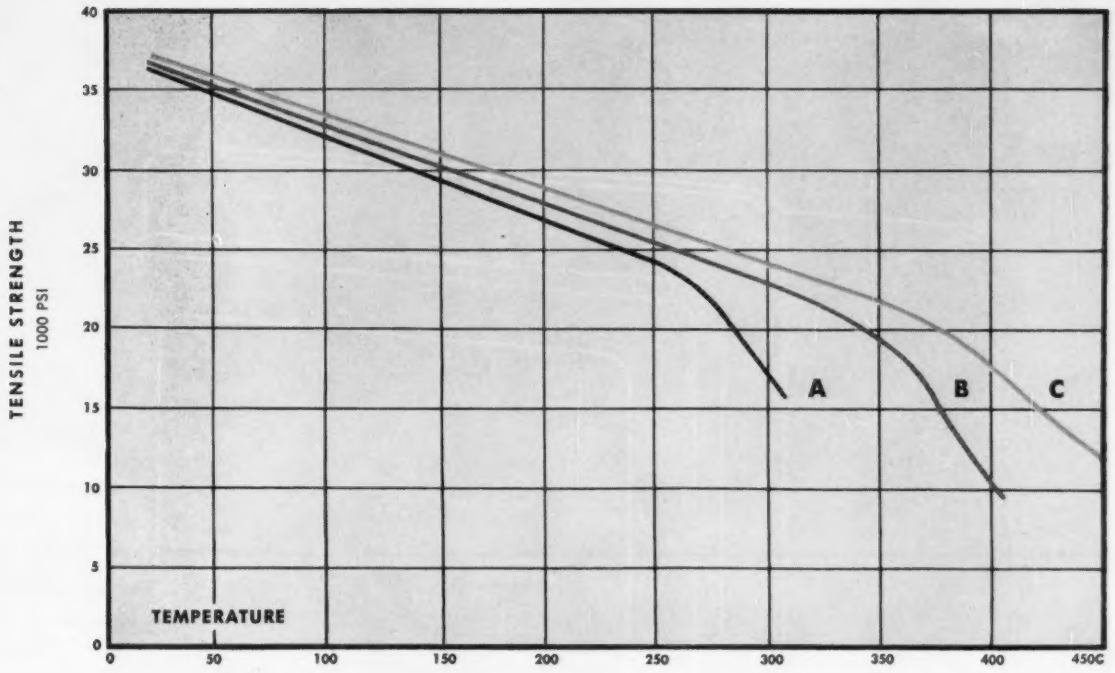
THE WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS

For more information circle 76 on reader service card.

How silver helps copper conductors at elevated temperatures



THE INFLUENCE of silver on the tensile properties of high-conductivity copper at elevated temperatures. Tests made by the Metallurgical Research Laboratory of The American Brass Company. The test pieces were copper strips, cold-rolled to a temper approximately that of hard-drawn rectangular bus bar.
A. Electrolytic copper, silver content normal
B. Electrolytic copper, silver 8.7 ounces per ton added
C. Electrolytic copper, silver 28 ounces per ton added

In heavily loaded motors and generators, the windings, collector rings, and commutators must retain their strength at the higher operating temperatures that have become the rule. And there are now many other places where copper conductors must operate at temperatures well above those heretofore considered normal.

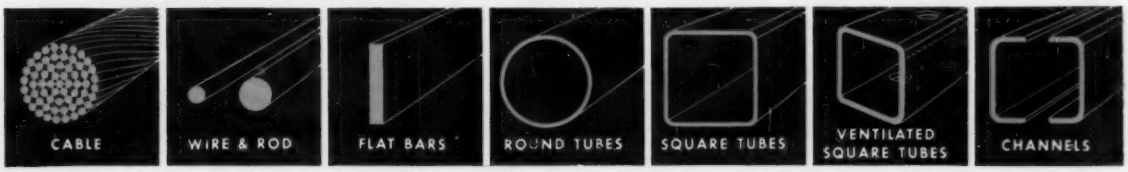
Electrolytic copper—with a very small amount of silver added—is superior to any other commercial conductor metal for use at these higher temperatures. Anaconda silver-bearing copper retains the structural design strength of the conductor at the higher operating temperatures. Annealing temperature is raised and softening delayed. The margin of safety is improved. How much gain you can count on is indicated by the chart above.

More complete information is available in the brand-new Fifth Edition of The American Brass Company's Publication C-25, "Anaconda Copper for Electrical Conductors." In addition, this 62-page booklet has convenient new tables giving physical and electrical data on all types of rigid bus conductors for the most commonly used sizes—plus a wealth of general information on the properties of copper conductors.

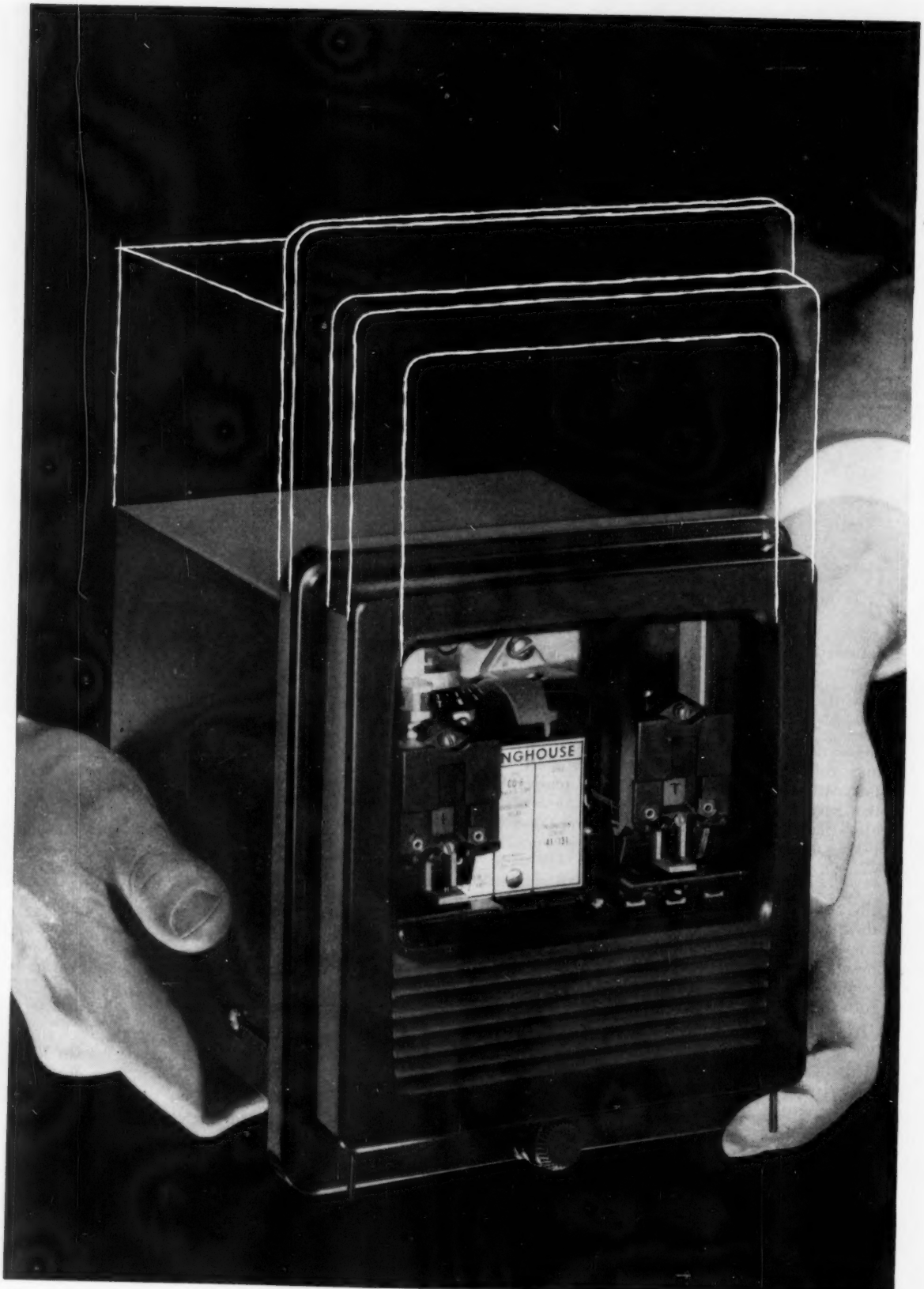
TECHNICAL SERVICE. The assistance of Anaconda specialists in the selection of conductors to meet your special problems is available to you. For such assistance – or to get a copy of "Anaconda Copper for Electrical Conductors" – see your nearby Anaconda representative. Or write: The American Brass Company, Waterbury 20, Conn. 56100

ANACONDA® COPPER CONDUCTORS

THERE'S AN ANACONDA ELECTRICAL CONDUCTOR FOR EVERY NEED



For more information circle 77 on reader service card.



For more information circle 78 on reader service card.

Good news about relay design:

Size reduced one-third . . . panel space saved, improved operating features

New-design Westinghouse relays and Flexitest* cases are one-third smaller than previous designs, enable you to mount more relays per panel. Result: significant savings in space and construction costs.

Even though these units are more compact, components are more readily accessible . . . and operating efficiency has been improved.

This advanced design offers other important benefits, too. A universal case design permits either semi-flush or projection mounting. Number of styles has been reduced two-thirds to simplify ordering and stocking. Modern lines give case an attractive appearance.

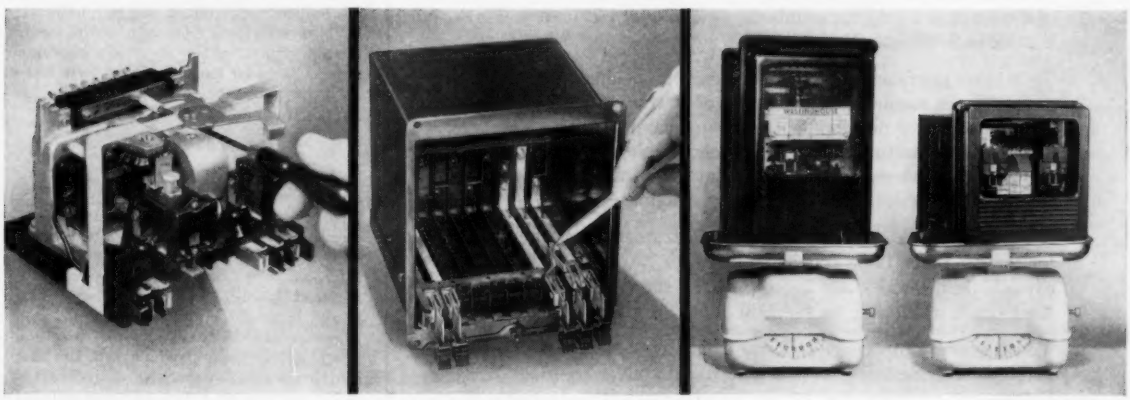
Whether you buy or build switchboards, be sure to specify new-design Westinghouse relays in Flexitest cases. They'll help you save space, assure reliable relaying operation, simplify maintenance and testing.

For further information about these newly designed relays and cases, contact your Westinghouse sales engineer and ask for a copy of B-6578, or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-40484

*Trade-Mark

COMPARISON OF SPACE REQUIRED — OLD AND NEW RELAYS

Type Relay	CO		CV		CR	
	Old	New	Old	New	Old	New
Number of relays in same space	5	7	5	7	5	8



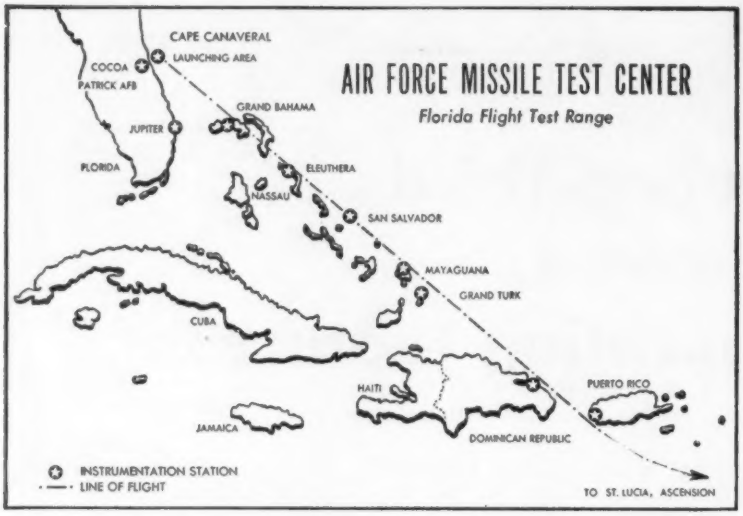
Accessibility—New-design chassis frame allows ready inspection and adjustment of operating elements. New latching arms provide positive locking for chassis, open for removal of operating unit.

Ease of Inspection—Strap-type connectors from switch blade to case terminal are visible, eliminating tracing circuit. Position of short-circuiting contacts visible even with relay unit in case.

Less Weight—Units weigh one-third less than earlier designs . . . are easier to handle and save customer stocking space. Although unit is more compact, it sets a new high in performance.

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING FOR **YOU!***



Engineers and Scientists:

INSTRUMENTATION SYSTEMS ENGINEERING
for **MILITARY APPLICATIONS**

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IN THESE NEW PROGRAMS AT THE MISSILE TEST PROJECT, FLORIDA

Have you as an engineer or scientist considered the problems and projects associated with the instrumentation and control of a long range missile, guided over a course that extends thousands of miles?

To achieve precision performance, missile launching and guidance require a vast network of instrumentation and control. New development programs have created challenging opportunities for Electronics Engineers and Scientists who are interested in data acquisition, transmission, recording and processing systems.

A world leader in electronics provides instrumentation for the Air Force Long Range Testing Laboratory, which extends from Patrick Air Force Base, on the Central East Coast of Florida, to the Mid South Atlantic.

You will enjoy top salaries, liberal company-paid benefits, and ideal Florida living for you and your family. Relocation assistance, too.

TODAY . . . *get complete information on arrangements for personal interview. Send a complete resume of your education and experience to:*

PERSONNEL MANAGER
MISSILE TEST PROJECT—Dept. N-9H
P. O. Box 1226
Melbourne, Florida

MISSILE TEST PROJECT
Melbourne, Florida

New Products

(*Continued from page 56A*)

Slotted Lines. A rugged and accurate portable slotted line, model *230*, originally produced for the U. S. Army Signal Corps is now available to industry from Narda Corporation. This impedance meter is used to measure voltage standing-wave ratios and impedances in the frequency range of 500 to 4,000 mc per second. It is specifically intended for measuring the VSWR of coaxial components equipped with type *N* connectors (male or female). The model *230B* is equipped for measuring 7/8-inch coaxial components. The instrument consists of a section of coaxial transmission line of the parallel plane type, a pick-up probe, and a radio frequency detector which uses *IN21B* and *IN23* crystals, and Narda *N610-B* bolometers. The parallel plane transmission line provides increased accuracy and ruggedness, and minimizes the effects of leakage and variations in probe depth.

▲ Item 79 on the card.

Klystron For 8,500 to 10,500-Mc Range. An "x" band, waveguide output, two-cavity klystron oscillator, which features excellent frequency stability and extremely low microphonics has been developed by the Amperex Electronic Corporation. This new tube design has been made available in any of three power classes, type *DX122* for 5 watts, type *DX123* for 20 watts, and type *DX124* for 150 watts minimum. It covers any fixed frequency in the 8,500 to 10,500-mc range. The tube satisfies the application requirements of guided missiles, radar, telemetering devices, and microwave relay links. Rugged in construction, the klystron is simple in operation so that no mechanical adjustments are required. It is electrostatically focused with easily modulated a-m or f-m and has a dispenser type cathode for long life. Complete technical data on the *DX122*, *DX123*, and *DX124* is available.

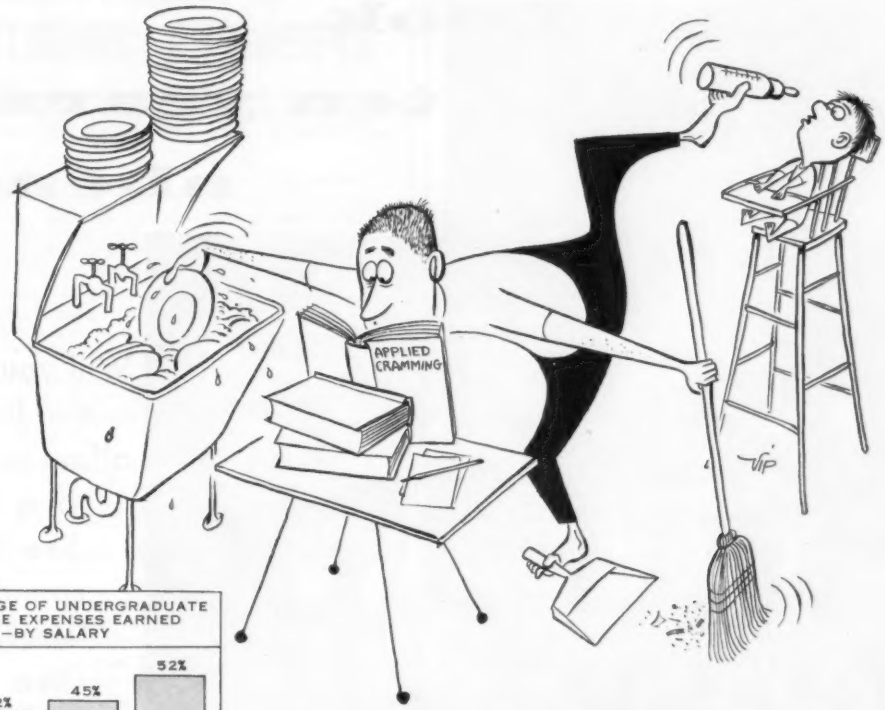
▲ Item 80 on the card.

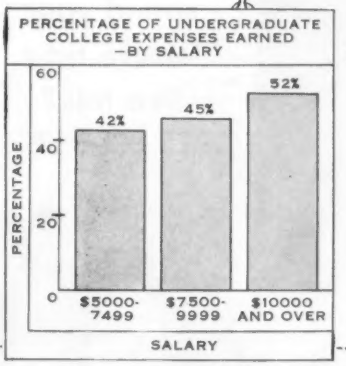
Rate Gyro. An oil-filled rate gyro which incorporates a nonheated temperature sensitive mechanism to maintain a linear damping over the ambient temperature range of −54 C to +71 C has been announced by G. M. Giannini and Company, Inc. Exceptionally accurate and rugged, model *36129* has a precision potentiometer pickoff which provides rate signals up to 70 volts with a linearity of ±1.5 per cent or better and repeatability of ±0.4 per cent. No amplification of the high level output is necessary in d-c telemetering or instrumentation applications and no demodulation is required for most a-c control systems. Hermetically sealed in an oil-filled, 2-inch diameter case, the mechanism is semifloated for protection during severe vibration (and shock up to 100 g). Model *36129* is available in standard rate ranges from ±15 to ±200 degrees per second with motor excitation by 115- or 200-volt 3-phase 400-cps power.

▲ Item 81 on the card.

(*Continued on page 80A*)

SIDELIGHTS ON THE SCIENTISTS *number* **5** *of a series*





Data obtained from a 20% random sample of the 2400 professional engineers and scientists on the staff of Hughes Research and Development Laboratories.

How to make $10,000 *(and up)*

Here at Hughes we have been analyzing the files of personal data regarding our scientists and engineers. Together with some additional facts cheerfully contributed by individuals, the findings reveal some interesting—and sometimes surprising—group characteristics and relationships. In this series we shall chart and attempt to interpret the results for you.

College Expenses Earned . . . and Present Salaries

The chart shown here represents the percentage of undergraduate college expenses earned—by present salaries at Hughes. The net result of this comparison is, that the higher the present salary of the individual—the more he earned while an undergraduate. College jobs included baby-sitting, "hashing", collecting laundry, lawn-mowing, car-washing, etc., etc. One scientist included in his list of college jobs—"Walking the Dean's rheumatic bulldog."

In the Hughes laboratories more than half of the engineers and scientists have had one or more years of graduate work; one in four has his Master's; one in 15 his Doctorate. Our research program is of wide variety and scope, affording exceptional freedom as well as superior facilities for these people. From every standpoint, it would be difficult to find a more exciting and rewarding climate for a career in science. Too, we are continually stepping up projects which will insure success in commercial as well as military work.

Hughes is pre-eminent as developer and manufacturer of the electronic armament control system now standard equipment on all Air Force all-weather interceptors. Our program also embraces ground systems radar, the Hughes Falcon and other guided missiles, automatic control, synthetic intelligence. Projects of broader commercial and scientific interest include research in and manufacture of semiconductors; electron tubes; digital and analog computation; data handling; navigation; production automation.

Scientific Staff Relations

HUGHES

The Laboratories now have positions open for all phases of work on ground and airborne digital computers—from logical design to production engineering. Why not write us?

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Culver City, Los Angeles County, California

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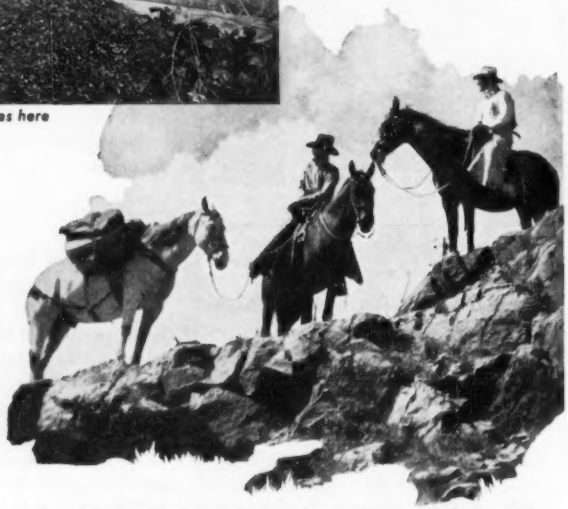
Will your income and location allow you to live in a home like this... spend your leisure time like this?



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Douglas has many things to offer the career-minded engineer!

...there's the stimulating daily contacts with men who have designed and built some of the world's finest aircraft and missiles!

...there's enough scope to the Douglas operation so a man can select the kind of work he likes best!

...there's security in the company's $2 Billion backlog of military and commercial contracts!

...and there's every prospect that in 10 years you'll be where you want to be professionally, and you'll be in both the income level and geographical location to enjoy life to its full.

For further information about opportunities with Douglas in Santa Monica, El Segundo and Long Beach, California and Tulsa, Oklahoma, write today to:

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Power Systems: requiring a good basic knowledge of electrical fundamentals plus familiarity with municipal electric power systems. Research is also being conducted on High Temperature Materials and Components, Electromagnetic Acceleration of Projectiles, Electromechanical Apparatus, Magnetic Circuits, and Electrical Measurements.

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Work on these and other projects should be particularly attractive to engineers who desire breadth and variety in their profession. Positions are available both at our Chicago and Tucson, Arizona locations.

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ARMOUR RESEARCH FOUNDATION
of Illinois Institute of Technology
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Chicago 16, Illinois

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Located in 32,000 population city on Lake Michigan, 55 miles from Chicago, a small, growing manufacturer of power and process control instrumentation has opening for young man 23 to 30 years old with B.S.E.E. degree and 1 or 2 years experience in electrical testing in central generating stations and sub-stations. Must have good knowledge of switchboard equipment and electrical generation and distribution circuits. Training in electrical switchboard design will be provided toward becoming electrical switchboard project engineer. Salary, vacation and insurance plans excellent. Send resume to Personnel Director

THE HAYS CORPORATION
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Assistants to project engineers will be interviewed.

Well rounded men having 3 to 4 years experience, BS degree, interested in design of specialty transformers and voltage regulators needed. This is an opportunity to work in New England with a smaller company. Send complete resume including education, experience, salary and history to:

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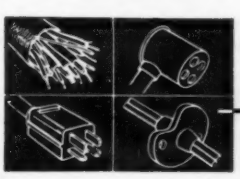

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▲ Circle 82 on the card.

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- Electronic
- Electrical
- Vacuum Tube
- Mechanical

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M. J. ZUNICK, Engineering Section
X-Ray Department, General Electric, Room CA-87
Milwaukee 1, Wisconsin

Progress Is Our Most Important Product

GENERAL ELECTRIC
X-RAY DEPARTMENT

(*Continued from page 76A*)

TRADE LITERATURE

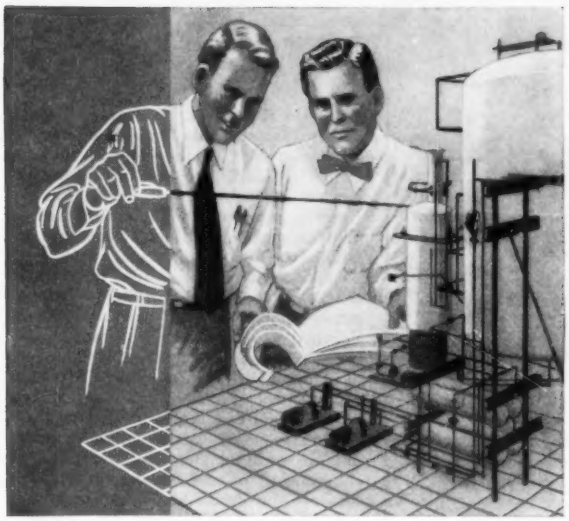
Industrial Capacitor Digest. A collection of recent trade magazine stories on the subject of industrial capacitors is now available from General Electric Company, Schenectady 5, N. Y. The digest stories are designed to point out how industrial capacitors installed at the load in a plant can pay a high return in power cost savings, released additional capacity, and better operating conditions.

Radiometry Booklet. Reviewed in this booklet are the principles, practices, and instrumentation of infrared radiometry. Radiometry is a new technique for temperature measurement with applications in aircraft and missile guidance, power plants, chemical installations, and in dozens of other industries. The object being measured can be at a low heat, literally miles away, and moving at a high rate of speed. For further information write to: Barnes Engineering Company, 30 Commerce Road, Stamford, Conn.

Fluid Power Booklet. "How Fluid Power Serves Industry and You" is an interesting, informative booklet written in nontechnical language under the direction of the Education Committee of the National Fluid Power Association. It explains that fluid power is the art of generating, controlling, and applying smooth effective power of pumped and compressed fluids (like oil and water) as used to push, pull, rotate, regulate, or drive the mechanisms of modern life. Interesting sketches and text point out the many applications of fluid power in several segments of industry and commerce. Free copies may be obtained by writing to the National Fluid Power Association, 1618 Orrington Avenue, Evanston, Ill.

Test Instrument Catalogue. For electric utilities and large industrials having generating plants, Multi-Amp now has available a complete catalogue of Multi-Amp test instruments for testing and calibrating current actuated protective devices. In presenting the full line of standard and special equipment for safety testing protective relays, oil circuit reclosers, and related devices, the catalogue contains product descriptions, application recommendations, illustrations, schematic diagrams, and essential technical data of interest to public utilities and electrical maintenance personnel of large plants and industries. A recapitulation of relay testing practice today, with recommendations on rapid and safe new techniques to inspect critical protective equipment on installation and periodically thereafter, is also included. Free copies of catalogue No. *3561* may be had on request to Multi-Amp Corporation, 10 Third Street, Newark, N. J.

(*Continued on page 82A*)



Engineers—

Ask P & G About Your Real Future

Engineering models like the one above play a vital part in providing Procter & Gamble engineers with a three-dimensional look at the future.

Naturally you can't build a scale model of *your own future*, but you can plan closely a *future* that will combine your technical skills with the greatest professional and personal opportunities. And in its Cincinnati engineering staffs for domestic and overseas activities P & G is ready to help you realize your engineering career plans in the following fields:

- Automatic Machinery
- Chemical Process Equipment
- Power Generation and Distribution
- Instrumentation and Control
- Building Design
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Procter & Gamble offers you:

- An immediate, challenging engineering role with one of the nation's leading manufacturers of soaps, detergents, drug products, food products and chemical specialties.
- A program of career development custom-tailored for your interests—whether they are of a technical, administrative or managerial nature.
- The opportunity to progress rapidly with a company that has doubled its business volume every 10 years since 1900. Over half of the company's total present business in household products is in brands not on the market 10 years ago. P & G has been cited by the American Institute of Management consistently as one of the nation's best-managed companies.

IF . . .

Your background qualifies you for any of the above opportunities . . .

You were graduated with an engineering degree within the last 10 years . . .

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IN ENGINEERING AT P & G
BY FILLING OUT AND MAILING
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Engineering Division
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Cincinnati 17, Ohio

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engineers

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. . . with B.S. degree and at least 5 years' experience in Electrical Power Controls and Operations.

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These positions will require 25% of your time spent on field tests and problems analysis in the power industry. The remaining time will be spent in Philadelphia. These are permanent positions.

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to Custom Design
Heating and Conditioning Equipment

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You will be working on such unusual products as large heating blankets for rockets, missiles, air-borne cameras, and laminated type heaters for Air Force high altitude helmets. Not only will you do the actual design, but you will have full liaison responsibility with manufacturing, marketing and the customer.

Reimbursed graduate study at Rensselaer Polytechnic and Union Colleges...pension rights, comprehensive insurance...a firm promotion-from-within policy... these are typical of what makes the GE engineering climate one of progress. Excellent starting salaries.

Please send resume to:

D. R. Barbour, Supervisor of Engineering

GENERAL ELECTRIC

Coxsackie, New York

Trade Literature

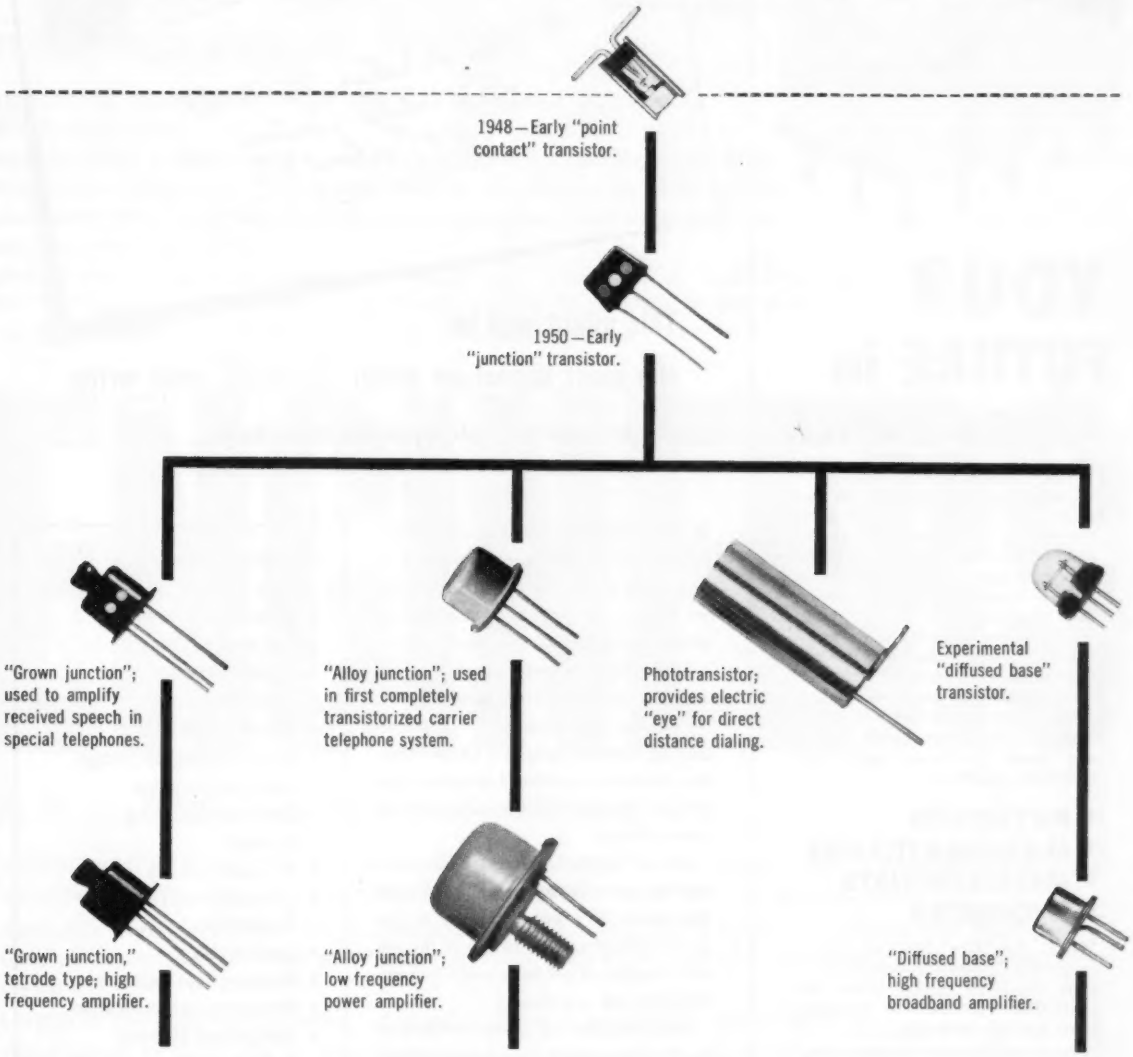
(*Continued from page 80A*)

First Aid Catalogue. A 6-page first aid catalogue is available from E. D. Bullard Company, 275 Eighth Street, San Francisco 3, Calif., and their distributors, located throughout the United States, Canada, and Central and South America. With each catalogue is included an "Instant Guide to First Aid" card. The card contains the latest information on first aid treatments and folds to fit into wallet or purse. These first aid kits are custom designed to fit the specifications of every industry and the Government. The catalogue contains a listing of over 100 unit packs, photographs of kits, catalogue numbers and complete descriptions of kits and units, simplifying the ordering of first aid kits and supplies. Included also in the circular, in addition to unit first aid kits, are the Pacific kit for use in plants, aluminum cylindrical kits for pipeline, lumber and drilling industries, snake bite kits, small pocket packs, and a number of special kits.

Nickel and Nickel Alloy Tubing Catalogue. "Superior Tube Nickel and Nickel Alloy Tubing," a 20-page catalogue has been published by Superior Tube Company featuring handbook information on nickel and nickel alloys for use by designers, production engineers, and purchasing executives. The catalogue points out that the company's metallurgical engineers may be consulted at any time for advice on alloy selection, heat treatment, and fabricating procedures for small diameter tubing. A 6-page section on the selection and application of the tubing describes characteristics of each analysis and illustrates typical applications. The tubing described in the catalogue is supplied in standard outer diameters (OD) from 0.012 to 1.125 inches. Monel tubing also is available from $1^1/_8$ to $2^1/_{16}$ inches OD with walls from 0.010 to 0.025 inch. Copies of Catalogue *12* are available free on request by writing to Superior Tube Company, 1517 Germantown Avenue Norristown, Pa.

Cement Bulletins. The development department of the Portland Cement Association, 33 West Grand Avenue, Chicago 10, Ill., has issued two bulletins. Bulletin *D3*, "Investigation of the Moisture-Volume Stability of Concrete Masonry Units," presents test results and conclusions of a laboratory investigation of the dimensional changes that take place in concrete masonry units when exposed to various simulated job-site and service moisture conditions. It also presents data from exploratory studies of the effect of carbonation on the volume stability of concrete masonry units. Bulletin *D4*, "A Method for Determining the Moisture Condition of Hardened Concrete in Terms of Relative Humidity" describes development work which led to a procedure for determining this relative humidity in 15 to 30 minutes, and presents a simple test method which will be useful either as an acceptance test or as a plant inspection test for concrete masonry units.

TRANSISTORS—first family of electronics


1948—Early "point contact" transistor.
1950—Early "junction" transistor.
"Grown junction"; used to amplify received speech in special telephones.
"Alloy junction"; used in first completely transistorized carrier telephone system.
Phototransistor; provides electric "eye" for direct distance dialing.
Experimental "diffused base" transistor.
"Grown junction," tetrode type; high frequency amplifier.
"Alloy junction"; low frequency power amplifier.
"Diffused base"; high frequency broadband amplifier.

In 1948 Bell scientists announced their invention of the transistor—a tiny device able to amplify signals a hundred thousand times using a small fraction of the power of an electron tube.

From this original "point contact" transistor has grown a distinguished family of immense usefulness to electronics. Some of its leading members are shown here, in approximate actual size, with their scientific type names.

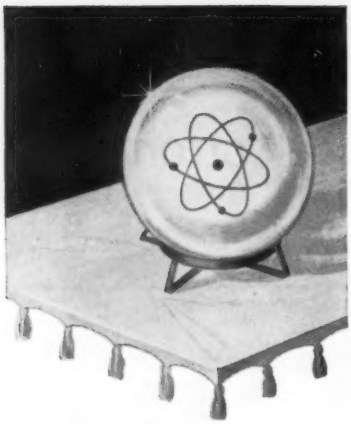
For telephony the transistor has opened the way for notable advances in instruments, transmission and switching. Elsewhere it has opened the way to advances in hearing aids, television, computers, portable radios and numerous military applications.

Bell's transistor family is typical of the Bell Laboratories research that helps keep your telephone service the world's best—and at the same time contributes importantly to other fields of technology.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

For more information circle 83 on reader service card.



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Atomic power, we feel, offers outstanding opportunity for an engineer or scientist to grow professionally. It's new enough so that the work is challenging; still it's well enough established so that a capable man can make real progress.

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- Carrier, Wire-Line
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- Data Processing
- Digital Techniques
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- Electronic Carillons
- Electronic Switching
- Infrared
- Intercom Systems
- Laboratory and Test Engineering
- Loudspeaker
- Magnetic Tape Recorders
- Microwave, communication
- Navigational Systems
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OPPORTUNITIES IN DESIGN, development, production-engineering and packaging of mechanical, electronic and electro-mechanical devices.

SOME EXPERIENCE IN DEVELOPMENT, design and application of high-speed, light-weight mechanisms of the intermittent-motion type—or experience in digital devices and components is desirable, but not essential.

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YOUR WORK AT NCR with its friendly, family atmosphere, where you work with people who, like yourself, have decided to build their professional future with NCR.

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Send resume of
your education, experience
and geographic preference to:
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Electronic & Mechanical

PHYSICISTS:

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Melpar's R & D operations are centered near and in two of the country's more desirable communities: Washington D. C., Watertown and Boston, Massachusetts, each of which affords engineers the opportunity to enjoy research, cultural and recreational resources well above the average.

Regardless of which locale he selects, the engineer will find that our advancement policies and organizational structure provide opportunities uncommon to the industry as a whole.

Individual performance heads the list of factors which determine progress. Regardless of age, experience or tenure, an engineer is given more complex responsibilities *as soon as he is ready*. There is always room to move ahead at Melpar, because we have doubled in size every 18 months for the past 10 years, with a proportionate increase in top and middle level openings.

Our engineers gain comprehensive experience in all phases of engineering problems. Each is assigned to a project team which is charged with responsibility for *whole* problems, from design concept to completion of prototype.

The engineer will find each of Melpar's laboratories splendidly equipped with an eye to both present and future needs. Fully air-conditioned, each laboratory has recently acquired additional facilities.

We extend financial support to those who intend to pursue advanced study. Fully accredited courses are available at our main laboratories.

Write for *complete* information, indicating geographical preference. Qualified candidates will be invited to visit Melpar laboratories at Company expense.

Top Level Openings Exist In These Fields: Network Theory • Systems Evaluation • Microwave Technique • UHF, VHF, or SHF Receivers • Analog Computers • Magnetic Tape Handling • Digital Computers • Radar and Countermeasures • Packaging Electronic Equipment • Pulse Circuitry • Microwave Filters • Flight Simulators • Servomechanisms • Subminiaturization • Electro-Mechanical Design • Small Mechanisms • Quality Control and Test Engineering

Write: Technical Personnel Representative

MELPAR *Incorporated*

A Subsidiary of Westinghouse Air Brake Company

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Positions also available at our laboratories in Boston and Watertown, Mass.

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AC *needs*

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... Electrical

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GM INERTIAL GUIDANCE SYSTEM PROGRAM

ELECTRONICS DIV.,

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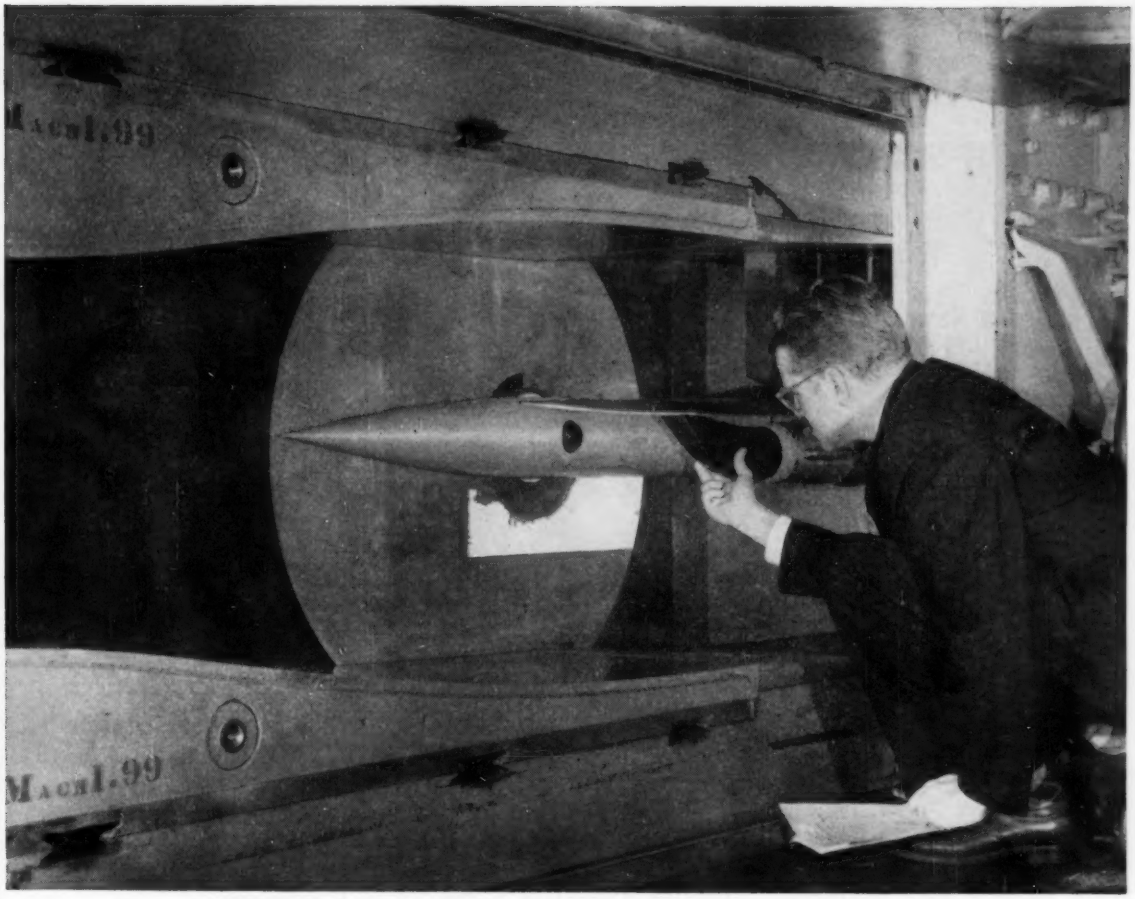

Supersonic jet inlet: an example of Boeing-Wichita research

This Boeing-Wichita engineer is checking the installation of a model supersonic engine inlet design prior to wind tunnel testing at M.I.T. Data on engine inlet performance at high Mach numbers obtained from such tests is now being applied to the design of future supersonic airplanes. This is just one example of Boeing-Wichita's continuing development of advanced aircraft and associated system components.

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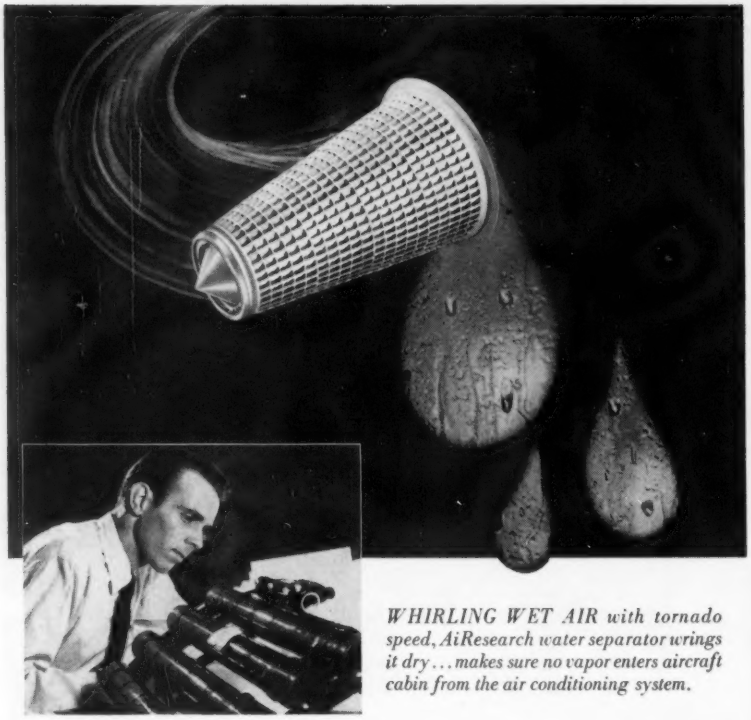

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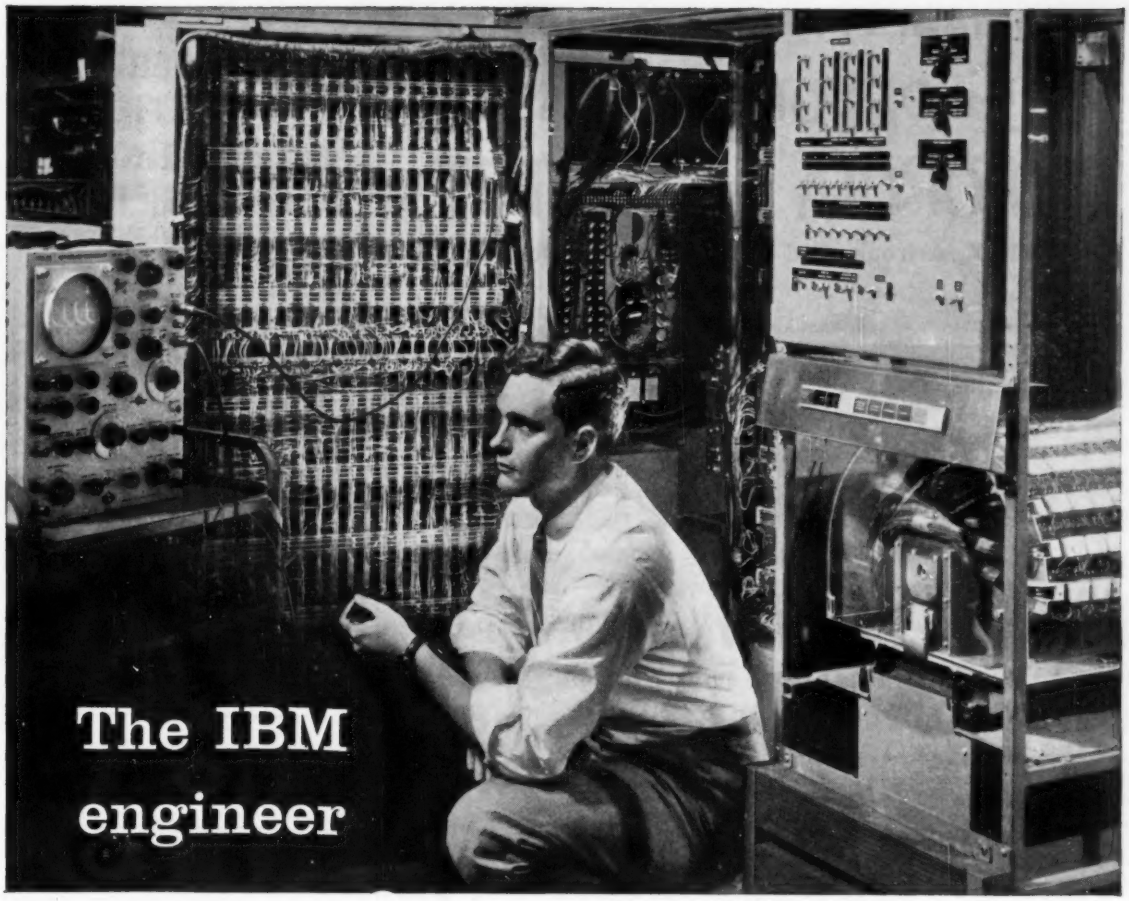

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(Continued on page 96A)

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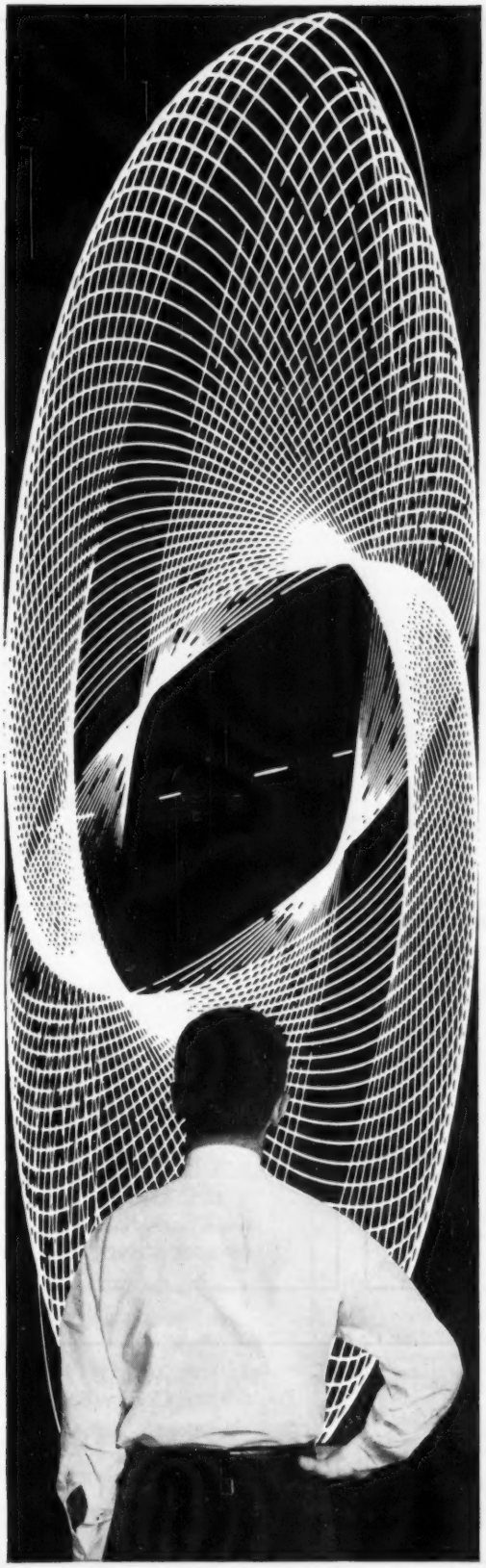

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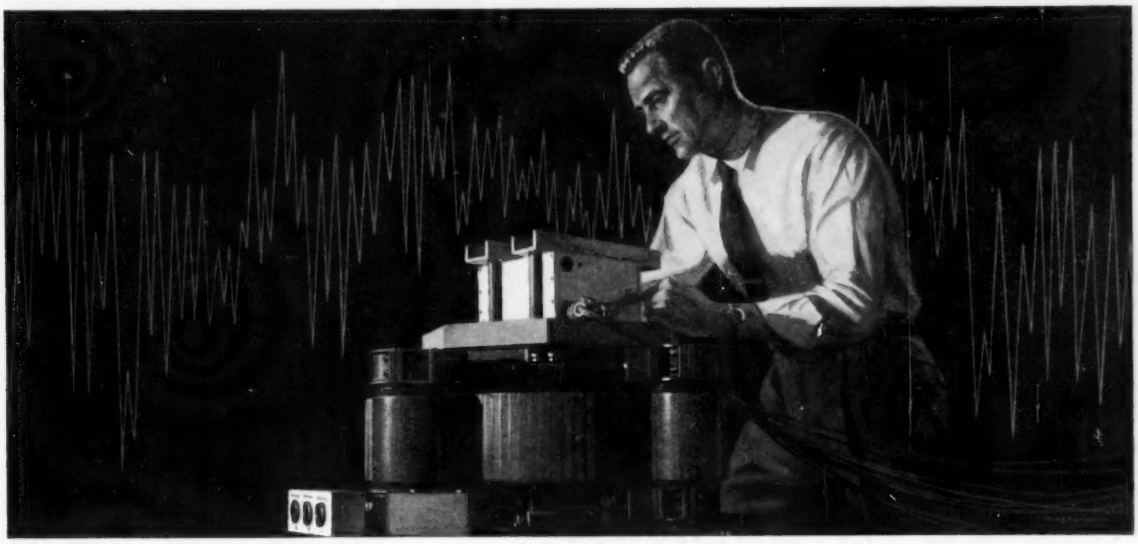

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(Continued from page 91A)

Salary, from $6800 a year. (b) Graduate Electrical Engineer or equivalent experience in photometry involving tests of all types of lighting equipment, light sources and lighting materials. Salary, from $5500 a year. Location, New York Metropolitan area. W-3554.

RECENT GRADUATE ELECTRICAL ENGINEERS for a testing laboratory. (a) One for testing, checking and calibrating instruments and test apparatus, both electrical and physical, to conduct in-plant test and certification of clients' instrumentation in industrial plants. Some travel. (b) One for cable testing, to perform in-plant inspection and witness testing of high voltage underground power cable. Training period. Some travel. (c) One for electrical testing, with specialized knowledge of instruments and instrument testing, particularly watthour meters, all types, and rotating standards. Salaries: (a, b) from $4500 a year; (c) from $5000 a year. Location, New York Metropolitan area. W-3555.

ENGINEERS for instrumental work on diversifed nuclear chemistry research project in a major university. (a) Electronics Engineer; (b) Physicist; (c) Chemist. Should have electronics experience. Opportunities for cooperative and individual research and for part-time graduate study with remission of tuition. Location, East. W-3561.

TECHNICAL ADVERTISING WRITER, 27–35, electrical graduate, with technical writing, advertising or publication experience, for work on product information literature covering industrial electrical apparatus. Should be able to put a publication together. Salary open, depending upon experience and demonstrated ability. Location, western Pennsylvania. W-3577.

PLANT MAINTENANCE ENGINEER, graduate electrical, for electro-manganese plant. Salary open. Location, Tennessee. W-3591.

CHIEF POWER ENGINEER, electrical or mechanical graduate, with at least ten years' hydro-electric power plant design and construction experience. Salary, $12,000–$14,000 a year, plus extras. Location, Philippines. F-3600.

ELECTRICAL ENGINEERS. (a) Senior Electrical Engineers for research, development and design of both magnetic and transistor amplification circuits. Salary open. (b) Junior Electrical Engineers, preferably with some experience, for development and design of both magnetic and transistor amplification circuits. Salaries open. Location, Newark, N. J. area. W-3605.

PROJECT DESIGN ENGINEER, 25–35, electrical or mechanical graduate, with a minimum of three years' experience with a company manufacturing low capacity rotary or toggle switches acting as a design engineer on this type of product. Duties will include design of low capacity rotary switches, improvement of design of subminiature rotary switch now in production, etc. Salary to start, $7500 a year. Location, Connecticut. W-3606.

PLANT ENGINEER, minimum B.S. in electrical or mechanical engineering, and at least five years' of plant engineering experience in electrical or electronic manufacturing or equivalent. Will supervise and direct the activities of the plant engineering department. Salary, $7488–$8844 a year. Location, Pennsylvania. W-3618.

PHYSICIST, physics or engineering graduate, with five years' optical and mechanical devices experience, to assist in design and development of photographic equipment. Salary, $7800–$10,400 a year. Location, Long Island, N. Y. W-3625.

SALES ENGINEERS, under 35, degree in electrical engineering or electronics; sales aptitude; previous sales not necessary. Work will involve sales of electronic equipment to the Federal government armed services. Must be U. S. citizens. Salaries open. Territory either Dayton, Ohio or Washington, D. C. areas; some traveling. W-3628.

GENERAL SUPERINTENDENT, engineering degree or equivalent, with several years, supervisory production experience in thermo products such as heat exchangers, evaporators, pressure vessels, steel pipe, etc., for chemical power and petroleum industries. Salary, $12,000–$15,000 a year. Location, upstate New York. W-3634.

FIELD ENGINEER, electrical graduate, 25–45, with experience in electronics, application, use, some experiment. Will act as consultant-advisor to military on electronic equipment, prod. radar, missile, sonar projects. 10–20% travel. Salary, $5000–$7000 a year. Territory nationwide. C-5141.

GUIDANCE SYSTEMS RESEARCH ENGINEER, electrical, math or physics graduate, 25–45, with at least five years' in electronic guidance systems research or development; know circuit design for homing systems. Will do research and development in the above, beam riders, command systems, antenna systems, capabilities, telemetry, comparator circuits, basic analog computers and/or guidance elements. Must be U. S. citizen. FBI clearance. Salary, $15,000 a year. Employer will negotiate fee. Location, Ohio. C-5159.

TELEMETERING RESEARCH ENGINEER, electrical, math or physics graduate, 25–45, with at least five years' research and development experience in telemetering systems; know FM-FM and PDM systems. Will do design, research and development of telemetering systems including both airborne and ground facilities Must be U. S. citizen and be clearable with FBI. Salary, $15,000 a year. Employer will negotiate fee. Location, Ohio. C-5160.

ELECTROMAGNETIC WAVE RESEARCH ENGINEER, physics, math or electrical graduate, to 45, with at least five years' experience in research of electromagnetic wave theories. Know varying dielectric constants and conductivities. Will do research in above and ionosphere effects, meteorological and sun spot activity as to frequency, forward scattering phenomena, antenna, radiation and propagation studies covering VLF up through microwave spectrum. Must be U. S. citizen clearable by FBI. Salary, $15,000 a year. Employer will negotiate fee. Location, Ohio. C-5161.

NAVIGATION SYSTEMS RESEARCH ENGINEER, electrical, math or physics graduate, to 45, with at least four years' experience in design, development or research in Loran, Becca, Tridop and/or Raydist systems. Know electromagnetic radiation. Will do research and development on systems similar to the above. Must be U. S. citizen and clearable by FBI. Salary, $12,000 a year. Employer will negotiate fee. Location, Ohio. C-5162.

RADAR EQUIPMENT DESIGN ENGINEER, electrical or mechanical graduate, to 35, with at least four years experience in analytical and theoretical design of radar equipment; know signal-to-noise ratio. Will design above equipment and necessary hardware. Should be strong in theory and analysis. Must be U. S. citizen, clearable by the FBI. Salary, $9000 a year. Employer will negotiate fee. Location, Ohio. C-5165.

CHIEF ENGINEER, to 50, with experience in guided missile, drones or aircraft instrumentation. Will be in charge of R & D on guided missile devices. Also need a project engineer to work under above. Salary, $7500–$12,000 a year. Employer will negotiate fee. Location, western Chicago suburb. C-5181.

PRODUCTION SUPERVISOR, electrical background, with at least three years' experience in production work on transformers or electrical equipment. Will supervise production, plan methods, etc., for a manufacturer of transformers. Salary, $9000–$10,000 a year. Employer will pay fee. Location, Chicago, Ill. C-5208.

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PHYSICISTS

METALLURGISTS

3 Positions Open for Project Leaders at General Electric's Tube Dept.

The Project Leaders who fill these positions with this growing GE department, will be concerned with advancing the "art" of power tubes. Demonstrated leadership ability is needed, as the work involves not only primary responsibility for advanced projects but the training and advising of junior engineers.

Have you had intensive experience

in one of the following:

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TRAVELING WAVE TUBES

If the answer is, "YES", then we may well have the very opportunity-filled opening you've been looking for.

Also opportunity for

A TUBE CONSTRUCTION SPECIALIST

with extensive experience

Interested? Contact Gus Root . . .

A convenient interview can be arranged and a trip to Schenectady to look us over at our expense.

GENERAL ELECTRIC

Tube Department

One River Road, Schenectady 5, N. Y.

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MICROWAVE TUBE DESIGN SUPERVISOR

with 5 or more years' experience designing such tubes as

Magnetrons, Klystrons, and Traveling Wave Tubes.

Must have had two years' supervisory experience.

Expanded development program, progressive company provides opening for above.

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Send letter or resumé to:—

Box 463 c/o Electrical Engineering
500 Fifth Ave., New York 36, N. Y.

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$10,000 to $17,000 up
FEE PAID

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The firm is well known and maintains high professional standards. Location: in the suburbs near metropolitan New York City

Advanced degrees are desirable though not mandatory. The age bracket is 30–45 years. Address resumes to David L. Golan, 100 West 42nd St., Room 203, New York, N. Y.

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AGENCY

ENGINEERS

ELECTRIC BOAT
STEPS-UP
NUCLEAR SUBMARINE PROGRAM

offers unusual growth opportunities to engineers

Two years ago, world attention centered on Electric Boat at Groton, Connecticut where scientific boldness harnessed the power of atomic energy to launch the Nautilus, which will soon be followed by its sister ship, Seawolf. Next to glide down the ways will be even more powerful versions . . . a third, fourth and fifth nuclear powered craft.

Now, engineers who are cognizant of the implications of the Atomic Age are concentrating their interest on Electric Boat. The following opportunities exist for:

a) **Naval Architects**

b) **Mechanical and Electrical Engineers** with 3 to 5 years experience in the application of mechanical and electrical marine power plant equipment.

c) **Electrical and/or Mechanical Engineers** for basic design using analog computers, with respect to control systems, motor control circuits, power plant, speed and voltage regulators or fluid flow and thermodynamics. Familiarity with engine room and reactor plant electrical systems and controls desirable.

At Electric Boat your professional success is spurred by company sponsored courses at the plant, advanced study at leading universities, and by attention to broader professional growth by immediate supervision.

Electric Boat's location in Groton on the lovely shore of Long Island Sound makes life as pleasant as your job is stimulating. The surrounding resort area is well known for its year-round sports and recreational activities. And, you have all the advantages of nearby New York and Boston as well.

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Division of General Dynamics Corporation
GROTON • CONNECTICUT

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Degree and U. S. Citizenship Required.

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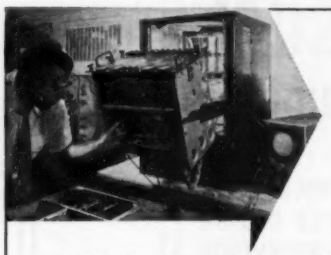
CHICAGO MIDWAY LABORATORIES
6220 South Drexel Ave., Chicago 37, Illinois Butterfield 8-6625



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Challenging Opportunities at Hycon for Electronic and Mechanical Engineers and Physicists

Hycon wants men who *won't* settle for less than a responsible, creative position. These men aim high—their futures *must* promise unlimited growth plus security.

Hycon is a well-established, rapidly growing company. Currently, design, development and production are at a high key in the following fields:

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- Electronic Test Equipment
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- Electro-Mechanical Instruments
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If you have training or experience in the above fields, write: Robert J. Hansen, Dept. H8.

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P.S.: See us at the WESCON SHOW, August 21-24, Booth 241-2, Pan Pacific Auditorium, Los Angeles. Examples of Hycon's widespread operations displayed there will surprise any forward-looking engineer.

Career Opportunities in

RADAR DEVELOPMENT AND DESIGN

at WESTINGHOUSE *in* BALTIMORE

The following openings in Radar Development Design are typical of the many outstanding career opportunities open to qualified Electrical Engineers or Physicists at the Baltimore Divisions of Westinghouse.

A major expansion program now in progress offers you opportunity for unlimited professional growth and recognition with a career company.

You will work as part of an engineering team responsible for the research, design, development, testing and field engineering of airborne, ground, and shipboard electronic systems. While working, you may continue your graduate studies toward M.S. or Ph.D. Degrees, and Westinghouse will pay your tuition expenses.

RADAR RANGE TRACKING

Design of airborne fire control radar range tracking circuitry for Fixed Fire Control Systems. Must be familiar with design and use of d.c. amplifiers and have a working knowledge of servo-mechanism analysis.

HIGH POWER RADAR TRANSMITTERS

Development and application of very high power klystrons, tetrodes and travelling wave tubes for fixed station and portable equipment in the U.H.F. and microwave frequency range.

SPECIAL RADAR DEVICES

Advanced development of a pulse doppler tail warning radar with particular concentration on receiver portion of unit. Includes establishment and review of block diagram of receiving section, design of circuitry, analysis of any problems that develop and confirmation that design is satisfactory. The latter requires devising special tests.

HIGH POWER RADAR MODULATORS

Design and development of very high power pulse circuitry; power control; power regulation, equipment and personnel safety devices.

RADAR SYSTEMS

Technical project administration involving complete radar and weapons systems design, development and evaluation.

PULSE CIRCUITS FOR SURVEILLANCE RADAR

Develop and test pulse circuits and wide band video amplifiers for airborne radar systems. Engineering responsibility required for production to military specifications.

RADAR RECEIVERS

Applied research, development, and design of receivers for airborne and shipboard radar equipment in the field of IF strips, low noise front-ends, crystal mixers, stable local oscillators, plumbing. Coordination of the packaging design may also be required.

Many other outstanding opportunities exist at the Baltimore Divisions. If you are a qualified engineer, contact us at once.

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Send resume of education and experience to:
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Westinghouse Electric Corporation
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WESTINGHOUSE
BALTIMORE DIVISIONS

ELECTRONICS ENGINEERS

PACKAGING ENGINEER

To organize and lead new group on missile projects. Minimum requirements B.S.E.E. or M.E. with 5 years electronics packaging experience.

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For work on complex fire control systems and antenna design.

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For development of automatic flight control systems.

For qualified applicants, interviews can be arranged at your convenience—either in your city or at the McDonnell plant. Moving allowance and assistance from our Housing Department upon arrival in St. Louis. Please send detailed experience resume to:

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Excellent opportunities for engineers with well established East Coast Industrial Instrument Manufacturer now expanding branch office coverage.
Electrical, Mechanical, or Electronic Engineers preferred.
Openings for Sales Engineers in St. Louis and Los Angeles.
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Generous company paid benefits include hospitalization, pension, insurance, and vacation plans.

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Electrical graduate, preferably with some experience in electric transmission and distribution work. To assist in planning development on utility system in New York State. Liberal fringe benefits. Salary open.

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Two Electrical Engineer Draftsmen experienced in preparation of electrical wiring layouts for power plants, switchgear, electrical distribution systems and wiring layouts for industrial projects and buildings.

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WITH

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IN

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The Electronic Components Department of GE concentrates on the development and manufacture of new devices selling to producers of every type of electronic equipment, from T-V sets and digital computers, to factory automation and guidance systems for aircraft.

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Manufacturing Engineers, ME or EE, with 3 or more years experience in coil winding and application, to work on mass production of **new** inductive components.

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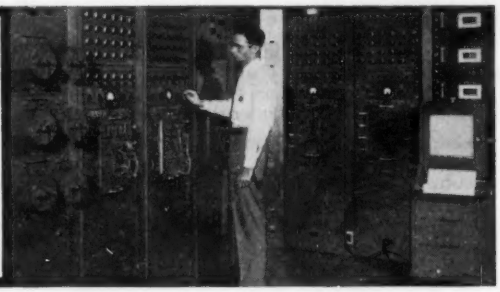
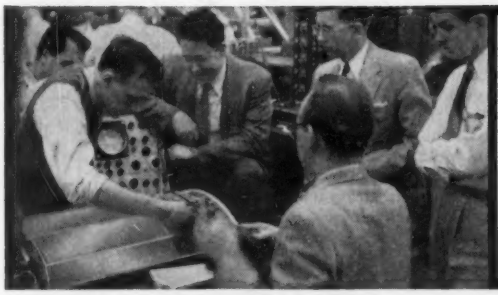
Engineers are needed to work on fundamental problems of analytical dynamics in missiles and weapons systems. Ability, training, and experience in analogue and digital computers, breadboards, prototype of missile equipment, and electronic and mechanical simulators are essential in these positions.





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Electronic Engineers with backgrounds in microwave, radar and servo systems are needed to design and develop guidance systems for a major guided missile project.

Mechanical Engineers are needed to design and develop electronic packaging for complex missile guidance systems.

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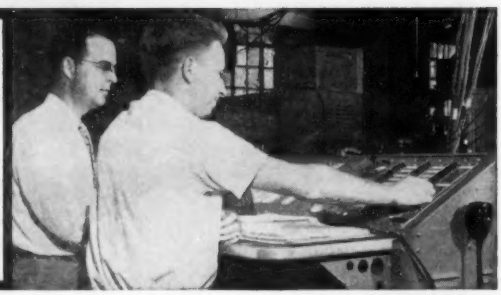
The whole is the sum of its parts. In our missile program, the high-caliber testing of the parts has an effect on the over-all missile performance. We want engineers with a good background in fundamentals who have experience in this systems type of testing.



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When answering an advertisement, send all replies to box number specified, c/o ELECTRICAL ENGINEERING, 500 Fifth Avenue, New York 36, N. Y., unless other address is given.

Positions Wanted

ENGINEER, BSEE, Family, 32, background industrial control design with large manufacturer including wire, material handling, and machine tool drives, AC and adjustable voltage feedback systems. West coast desired. Project design or plant engineer involving control preferred. Write Box 464.

BEE, 1949 MSEE in August, Age 30, U. S. Navy Veteran (Electronic Technician) and 5½ years experience with General Electric including Test and Creative Engineer Program; experience in instrument and home appliance design. Prefer location west of Mississippi River. Interests include servo, electronics and computers. Box 465.

ELECTRICAL ENGINEER, BSEE, PE by exam., family man. Six years with consultants to utilities, industry, municipalities, and government agencies. Special qualifications in contracts, client relations, and job coordination as Department head. Prefer midwest but no reservations. Box 466.

Positions Open

ELECTRONIC RESEARCH AND DEVELOPMENT, positions are now available at a university in the Southeast. Instructors required for September, 1956, $4000–4800; graduate assistants (M.S. in twelve months), $110 per month, tuition-free. Write Box 356.

RESEARCH ENGINEER to supervise research and development work in electrical laboratory of a small electrical manufacturing company specializing in electromechanical audio frequency responsive devices, and in the measurement of a-c and d-c characteristics of dielectrics. Graduate degree in electrical engineering necessary, preferably in high-voltage engineering, and with a sound mathematical background. Location Philadelphia. Box 406.

ENGINEER with graduate degree in electrical engineering for research and development work in small instrument manufacturing company in Philadelphia specializing in electro-mechanical audio frequency responsive devices and dielectric measurements. Box 440.

PROFESSOR OF ELECTRICAL ENGINEERING to each and do research in electromagnetic theory and do research in electro-magnetic-theory and antenna development. Should have Ph.D., teaching experience, and practical work in the antenna field. Salary $8,900–$12,000. Write Box 442.

ELECTRONICS ENGINEERS. Significant and challenging programs in the fields of radar-aeronautical systems and electronics. The programs are categorized in a broad sense as follows: RADAR-AERONAUTICAL SYSTEMS—All weather flight systems, radar control systems for airplanes and missiles, flight control computers, and specialized radar research. ELECTRONICS AND AUTOMATIC COMPUTERS—Communications and data processing systems electronic computer techniques, flight simulators, with detailed electronic circuitry involved in these applications. Cornell Aeronautical Laboratory, Inc., 4467 Genesee Street, Buffalo 21, New York.

PERMANENT STAFF POSITIONS IN ELECTRONICS open in Electrical Engineering Fall, 1956 at the South Dakota School of Mines and Technology, Rapid City, South Dakota. Ph.D. preferred but will consider M.S. degree. Expanding department to include graduate school. Ten month appointment, rank and salary commensurate with qualifications. Located in the Black Hills region of South Dakota. Write Head, Department of Electrical Engineering.

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UNIQUE POSITION IN CHEMICAL INDUSTRY—Electrical Control and Power Design Engineer—Graduate E.E.; 2–5 years experience in design or maintenance. Responsible for integrated electrical design of new chemical plant facilities. Write in confidence to: Mr. W. T. Durrett, Director of Engineering Inorganic Chemicals Division, Monsanto Chemical Company, St. Louis 1, Missouri.

AUSTRIAN MANUFACTURER DRUMSWITCHES and other industrial controls with office located New York requires energetic sales engineer able travel throughout USA. Drawing commission bright future. If interested write Box 453 stating all qualifications which should include some electrical engineering experience.

TRANSMISSION ENGINEER—Research and Development. Challenging opportunity for Electrical, Structural or Mechanical Engineer to work on high voltage transmission line problems. Preferably with considerable structural-mechanical experience involving conductor sag-tension, wind and ice loading, sleet, galloping conductors, vibration, fatigue, dampers, line hardware and accessories. Electrical experience, especially that involving corona, radio and television interference also desirable. Research and development experience not necessary but must be qualified to organize laboratory and field investigations and to evaluate the results. Salary open. Reply to Dr. E. W. Greenfield, Head, Electrical Engineering Branch, Department of Metallurgical Research, Kaiser Aluminum & Chemical Corporation, Spokane 69, Washington.

RESEARCH-TEACHING POSITION open September 1st for Engineer with experience in transistor circuitry. Must be capable of organizing research program and directing activities of graduate students. Salary at professorial level. Write to Department of Electrical Engineering, University of Alberta, Edmonton, Alberta, Canada.

SALES ENGINEER–SAN FRANCISCO for proposal preparation and sales correspondence on outdoor oil circuit breakers, power switching equipment, substations, electrical power connectors and bus supports. E.E. graduate with 2 years similar sales experience or equivalent. Salary $5500 to $6000. Federal Pacific Electric Company, 5815 Third Street, San Francisco 24, California.

REPRESENTATIVES WANTED—Qualified technical men to sell metering, control and transmission systems and components to petrochemical, process, waterworks, general industrial fields, consulting engineers, including O.E.M. Rapidly expanding firm offers liberal commission, exclusive territories. Write, giving lines and territory wanted to H. Katherman, SPARTON CONTROL SYSTEMS DIVISION, The Sparks-Withington Company, Jackson, Michigan.

TRANSFORMER ENGINEERS—(a) Experienced engineer to work on development of under load tap changer for power transformers. (b) Power engineer with experience in design of high voltage transformers. This is an opportunity to join an established firm with a national reputation of engineering and manufacturing quality transformers for more than a half century. Salary open. Direct reply to Industrial Relations Division, Wagner Electric Corporation, 6400 Plymouth Avenue, St. Louis 14, Missouri.

ELECTRICAL ENGINEER—Opportunity to work on varied problems of operation, construction, and maintenance involving locomotives, substations, and transmission lines for large electrified railroad in the Pacific Northwest. Traction experience desirable but not essential. Location—Seattle. Send resume to Electrical Engineer, Milwaukee Railroad, 618 White Building, Seattle 1, Washington.

ELECTRICAL ENGINEER familiar with power services on network systems and having a sales engineering background has an opportunity to work with a manufacturers sales representative with a view to establishing his own sales agency in the New York Metropolitan area if he will send experience details to Box 459.

ELECTRICAL ENGINEER, recent or June graduate interested in Railroad work. Applicant will receive 3 year Supervisory Training Course in power, signaling, communications and traction applications. Starting salary $440.00 per month with annual increases. All applicants to furnish photograph with resume of education, age, activities and experience, if any. Location Pennsylvania. Box 460.

ELECTRICAL ENGINEER with at least five years experience in industrial electrical engineering, preferably in a food or chemical process industry. Knowledge of contracts and specifications very helpful. Work involves building lighting, power distribution, and electrical control systems for process equipment. Permanent position with a large and established company long recognized as a leader in its field. Please furnish detailed resume and minimum salary requirement. Box 461.

(Continued on page 104A)

99.07* ENGINEERS and DESIGNERS

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THE ELECTRONICS DIVISION OF GENERAL MOTORS

* Our current monthly turnover figures are phenomenally good. Have been, we are proud to say, for years. It speaks well for the job opportunities, working conditions and the wages we pay our Engineers and Designers. Investigate for your future. Write us today.

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- JET and TURBO PROP ENGINE CONTROLS
- BOMBING NAVIGATIONAL COMPUTER SYSTEMS
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- U.H.F. COMMUNICATIONS
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Write today for Employment Application:
Mr. John F. Heffinger, Supervisor of Salaried Personnel

AC SPARK PLUG • THE ELECTRONICS DIVISION
GENERAL MOTORS CORPORATION
Milwaukee 2, Wis. Flint 2, Mich.

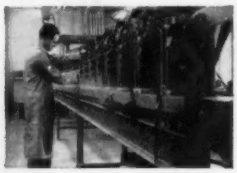
"MRI Offers Engineers a Way of Life"

At Midwest Research Institute I'm an important part of one of the nation's most respected independent industrial research and development organizations. MRI has made an outstanding record in 11 years, is firmly established, and has an assured future. We've just begun a five-year expansion program which will take us into many new fields. It also will require more engineers and physicists. You may be qualified for one of these desirable openings. Investigate, as I once did, this splendid opportunity for a better way of life!

I work in this beautiful new building in our civic center, near the art museum, university, medical center, fine homes and apartments. Our staff comes from all over the United States, from industry, armed forces, 81 universities. But no one remains a stranger long in friendly, progressive Kansas City!

My work is interesting, varied. I conceive projects, see them through, working with both large and small companies.

Research here is practical and productive, most of it undertaken for industry. My sponsor relationships mean a lot to me.



I'm an essential member of a stable research group. MRI's research philosophy creates new individual opportunities.

I write technical papers when the material is appropriate. MRI's reputation, and mine, grow through technical publications.

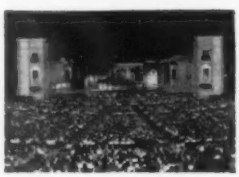
The Middle West is proud of MRI and the results of our efforts widely recognized. Our achievements are front-page news.

MRI adjoins unique, nationally noted Linda Hall technical library, with its unexcelled resources of scientific literature.

Kansas City is ideal for family life, too. We have a modern house in a nice neighborhood, near schools, churches, and parks.

The planned shopping center concept originated here. All sections boast complete units, with shops, restaurants, parking.

This is even the majors' new frontier. Our team's not in the first division yet, but we surely expect it to be soon.



Starlight theater's another good place to relax—good music, hit shows, Broadway stars, always fun for the whole family.

The Lake of the Ozarks features swimming, boating, fishing, and many other facilities for enjoyable weekend vacationing.

But perhaps our happiest hours are spent at home, with family, neighbors, friends. We've truly found a way of life we like.

If you'd like to make this YOUR way of life, too, let's hear from you!

MRI's five-year expansion plan creates many new opportunities NOW for engineers and scientists with B.S., M.S., or Ph.D. degrees. We can make you a surprisingly attractive offer in a professional assignment, with particular emphasis on the following fields: aerodynamics, applied mechanics, engineering design, electromechanics, electronics and communications, instrumentation and control, numerical analysis, physics, servo mechanisms, and stress analysis.

write Fred Stephens, Manager, Engineering Division

MIDWEST RESEARCH INSTITUTE

427 VOLKER BLVD., KANSAS CITY 10, MO.

Classified Advertising

(Continued from page 103A)

RESEARCH AND DEVELOPMENT ENGINEERS—Electrical and mechanical, interested in work involving design of equipment of a specialized nature, instrumentation research, and development of specialized test procedures. Should be capable of generating ideas and following them through the design and experimental stages. Position offers diversity of activities and excellent opportunities for creative work. Please send complete resume of education and experience to Southern Research Institute, 917 South 20th Street, Birmingham 5, Alabama.

TEACHING PERSONNEL—To teach undergraduate Electrical Engineering courses in power or communication. Three quarter teaching year with additional compensation for fourth quarter teaching. Opportunity for graduate study with financial assistance. Instructorship or Assistant Professorship depending upon qualifications. Program accredited by ECPD. Write to: Chairman, Department of Electrical Engineering, Fenn College, Cleveland 15, Ohio.

RETIRE IN FLORIDA—We are looking for a man 55–65 years of age to be paid a nice monthly salary to work about 10 days per month at his convenience. Must be good on line regulators, relays and breakers. Send resume to Bennett Rutherford Box 127 Graceville, Florida.

ELECTRICAL ENGINEER—For development and application work in power system control. Knowledge in electronics and servomechanisms desirable. Location, Western Pennsylvania. Reply stating age, education, experience and personal particulars. Salary open. Box 467.

A.I.E.E. TRANSACTIONS back volumes wanted to buy for cash and other periodicals–E. E. ASHLEY, 27 East 21st Street, New York 10, New York.

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Plants and Substations
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Including Underground Network Systems
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SYSTEM PLANNING ENGINEERS

Required by Operating Division of long established service and supervisory organization for large group of Electric Utilities located in eleven Latin American countries. Engineering assignments varied and interesting with responsibility. Salary commensurate with ability. Usual employe benefits. Reply giving age, education, experience, personal particulars and salary expected.

AMERICAN AND FOREIGN POWER COMPANY, INC. AND SUBSIDIARIES

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KNOPP Phase Shifter

Type Q

Every Degree between 90° leading to 90° lagging

You can have any leading or lagging phase angle by manually controlling the position of the rotor of the KNOPP PHASE SHIFTER.

Smoothly and continuously variable, it is quick and easy to use for testing electronic equipment and their control circuits, watt-hour meters, rotating standards wattmeters, power-factor indicators, induction relays, and instrument transformers.

Has two direct-reading scales. One is calibrated in degrees for the electrical angle of displacement; the other, in corresponding power-factor values.

Compensates for any phase displacement between current and potential of test setup that may be introduced by other portions of the circuit. Thus it gives true-power-factor-readings under all conditions.

The KNOPP PHASE SHIFTER offers superior performance, stability and high accuracy. Rated at 250 or 500 volt-amperes. Input: 120/240 volts, 3-phase, delta. Output: 120 or 240 volts, 3-phase, delta. Can be supplied in other ratings.

Write now for full details.

KNOPP INC.
4287 Holden St., Oakland 8, Calif.

▲ Circle 84 on the card.

INDUSTRIAL SALES ENGINEER

Opportunity to join the industrial sales engineering group of Wisconsin Power and Light Company located in south central Wisconsin. Personable, aggressive man, age 20–40, is needed immediately for industrial sales work. Plenty of opportunity to utilize your initiative, imagination and analytical ability in assisting industrial enterprises with gas and electric power problems.

Electrical engineering degree in recognized university necessary.

Salaried position plus bonus, regular employee benefits included with better-than-average opportunity to move into positions of even broader scope and more responsibility. No traveling required.

Write stating qualifications in detail direct to:

PERSONNEL DEPARTMENT
WISCONSIN POWER & LIGHT COMPANY
122 WEST WASHINGTON AVENUE
MADISON, WISCONSIN

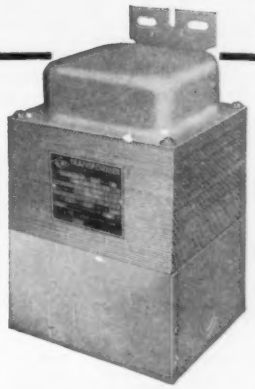
ELECTRICAL ENGINEERS STEAM POWER PLANTS

Excellent positions as project engineers for men experienced in the design and engineering of steam electric power plants and power systems.

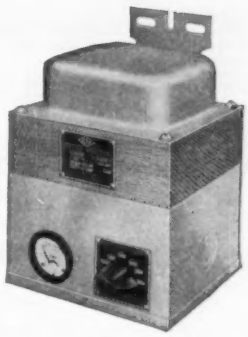
These are permanent positions offering opportunity for advancement with an established, recognized firm serving the growing electrical utility industry. Many liberal employee benefits, including pension plan. Please submit resume of education and experience. State age and salary requirements. All replies will be treated confidentially.

J. B. Chriaterson
SARGENT & LUNDY
140 So. Dearborn St., Chicago 3, Illinois

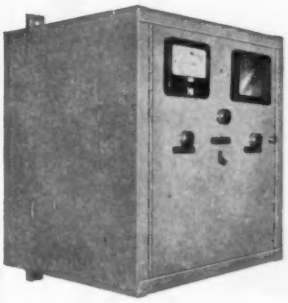
20,000 TRANSFORMER DESIGNS FROM WHICH TO CHOOSE



One good reason for discussing your transformer application with Acme Electric is the possibility that with our background of more than 20,000 designs, we can adapt standard parts to exactly fit special requirements.



For example, the top illustration is that of a 2 KVA 240/480 primary, 120/240 secondary volts, 60 cycle dry type power transformer. The illustration (right) is that of a 1500 watt voltage regulator having a manually adjusted output voltage range from 145 to 240 volts. Basically, the same design, but with modification each unit serves a different purpose.



This is a high voltage power supply for electrostatic dust collecting and air conditioning equipment. Operating on 230 volt single phase, 60 cycle, it supplies 12 KV direct current up to 30 ma. D.C. voltage is adjustable to load.

Your requirements may be more simple than these examples — or more difficult. Send your specifications.

ACME ELECTRIC CORPORATION
228 WATER ST. CUBA, NEW YORK

Acme ACME Electric
TRANSFORMERS

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Cannon Type "P" audio plugs are the standard of the microphone and low level sound fields. Zinc or steel shells. Hi-di-electric. All have 30-amp. contacts except the 8-contact unit which features 15-amp. contacts. Flashover voltages: 1300 to 1900 v at 60 cps. ac rms. Latch-lock feature. Cable entries 5/16" to 1/2". Send for Audio Bulletin. *Refer to Dept. 117*

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Representatives and distributors in all principal cities.

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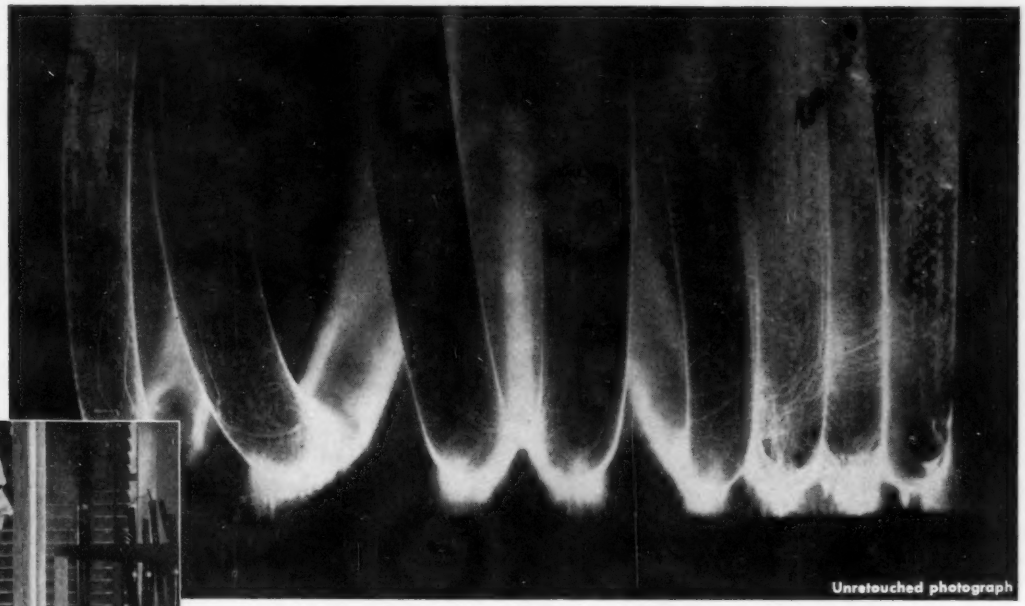
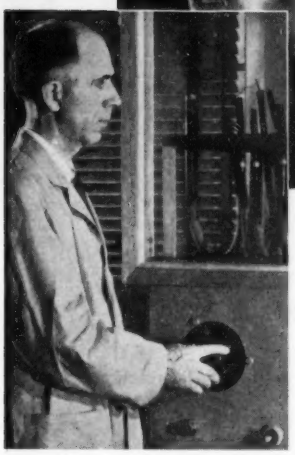
GRIZZLY® POWER CABLES



Unretouched photograph



Under High Ozone Attack resulting from excessive voltage outlast 9 other leading brands tested!

In United States Rubber Company's special wire and cable testing laboratory, scientific devices record how cables react under abnormally high voltage.

In this test, 6 samples of 5 KV unshielded U. S. Grizzly Power Cables were pitted against 26 other 5 KV samples made by 9 leading competitors. Lengths were bent into U-shapes, roughly 8 times the cable's over-all diameter. They were then placed upright on a grounded metal plate with bottom of "U" resting on plate. Then a conductor-to-plate potential of 40,000 volts was applied. The test was allowed to run until all cables failed, with elapsed time to failure carefully checked for each. The accompanying chart shows dramatically the overwhelming superiority of U. S. Grizzly Power Cable.

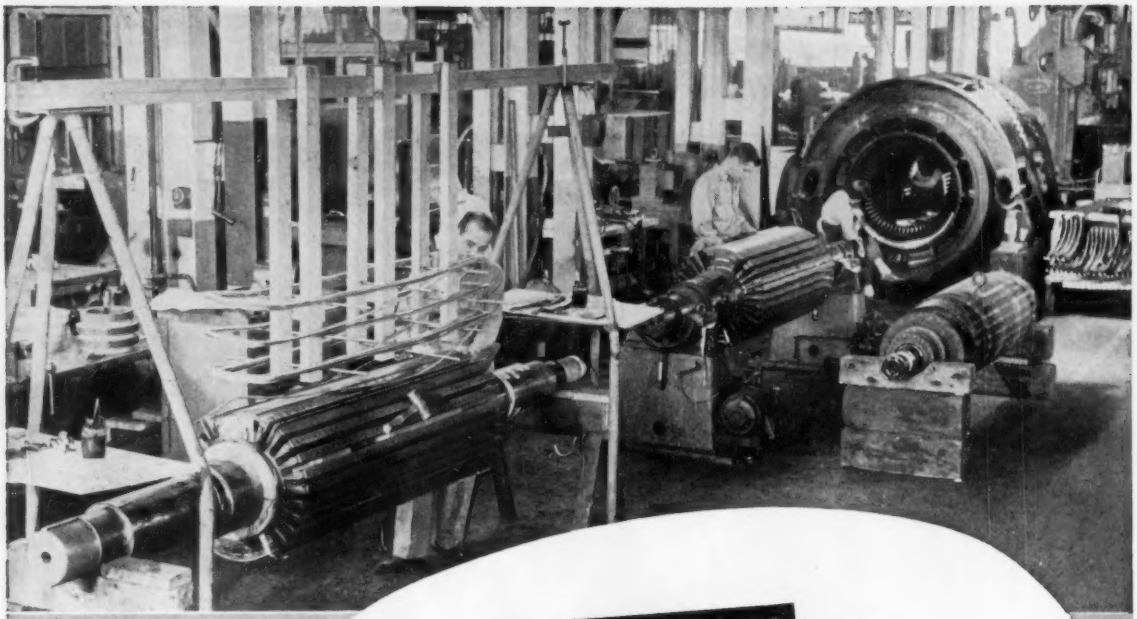
U. S. Grizzly Power Cables are obtainable at your "U.S." branch, distributor, or write us at Rockefeller Center, New York 20, N. Y.

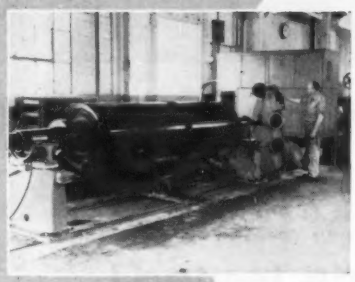
Manufacturer	No. of samples tested	Elapsed time to failure—in hrs. Lowest value	Highest value
"U.S."	6	2941	6030
A	2	0	3
B	5	0	92
C	2	0	.6
D	3	12.5	144
E	3	300	490
F	2	30	46
G	6	.1	2509
H	2	0	0
I	1	25	25

Electrical Wire & Cable Department

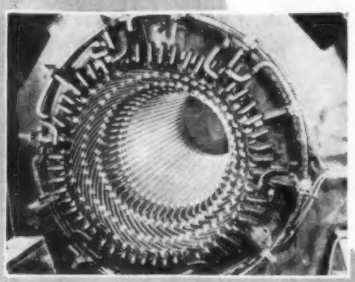
United States Rubber

For more information circle 87 on reader service card.





A rotor being dynamically balanced to close tolerances after rewinding to insure vibration-free operation.



A completed stator winding (Note special end turn tying and bracing).

CALL NATIONAL FOR FAST SERVICE AND TOP QUALITY ON REWINDING INDUSTRIAL TURBO GENERATORS

Fast service. Top quality for longer service life. Modernization for improved performance. You can count on these when you call on National for rewinding of your turbo generators.

The National shops are completely equipped and manned for the performance of all winding operations. When size or distance makes it impractical to ship the machine to us, we do the work on the spot. For complete details, just call your nearby National field engineer or drop us a line.

NATIONAL ELECTRIC COIL COMPANY

COLUMBUS 16, OHIO, U. S. A.

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION—REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

For more information circle 88 on reader service card.

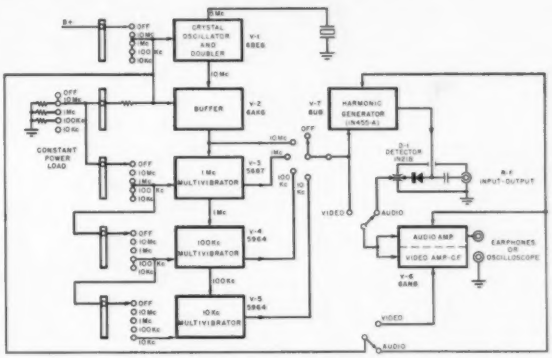
a complete new miniature standard for TIME/FREQUENCY measurements

The Type 1213-C Unit Time/Frequency Calibrator is a compact and inexpensive secondary standard of frequency. Contained in a single, small package are the circuits necessary for calibration operations which have hitherto required several instruments. This *one* instrument provides:

★ *Accurate 10-kc, 100-kc, 1-Mc, and 10-Mc fundamentals . . . plus harmonics to 1000 Mc*

★ *A crystal mixer of new design for use over the entire 1000-Mc range*

★ *Audio or video amplifier stages . . . . to amplify beats from the mixer for frequency calibration or to amplify the accurately known multivibrator square waves for time calibration.*



Calibration points for oscillators and receivers can be located without need for additional equipment (other than headphones). By calibrating against WWV, accuracy can be made much greater than required in most applications.

General-purpose frequency measurements, including standardization of TV transmitters to 1000 Mc, may be accomplished by feeding an interpolating oscillator frequency into the Calibrator's mixer along with the unknown frequency.

For calibrating CRO time axes, the Type 1213-P1 Differentiator provides timing pulses at intervals of 0.1, 1.0, 10.0 and 100 μsec, at the accuracy of the crystal-oscillator frequency.

In its video position, this instrument serves as an accurate timer for pulse applications.

SPECIFICATIONS

OUTPUT FREQUENCIES: 10 kc, 100 kc, 1 Mc and 10 Mc; harmonics usable to 10 Mc, 100 Mc, 500 Mc and 1000 Mc respectively.

NARROW-RANGE FREQUENCY ADJUSTMENT: 2.5 ppm variation (25 cycles at 10 Mc).

TOUCH-BUTTON FREQUENCY DEVIATOR: introduces a momentary 1.8 ppm frequency decrease for establishing "sense" in indications near zero-beat.

OUTPUT AMPLITUDES: 10v peak-to-peak on 10-Mc output from pulse amplifier; 30v p-to-p at lower frequencies.

OUTPUT IMPEDANCES: 300Ω from video cathode follower; capacitively coupled r-f output from crystal-diode harmonic generator.

STABILITY: 1 ppm/°C after one hour warm-up with Type 1201-A Regulated Power Supply.

SENSITIVITY: usable beat notes produced with 50-mv signal input to mixer.

Type 1213-C Unit Time/Frequency Calibrator, supplied with **Type 1213-P1** Differentiator **$195**

Type 1201-A Unit Regulated Power Supply ..... **$ 80**

Type 480-P403 Relay Rack Panel, for mounting both Calibrator and Power Supply ..... **$ 10**

GENERAL RADIO Company

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1150 York Road, Abington, Pa. **PHILADELPHIA**
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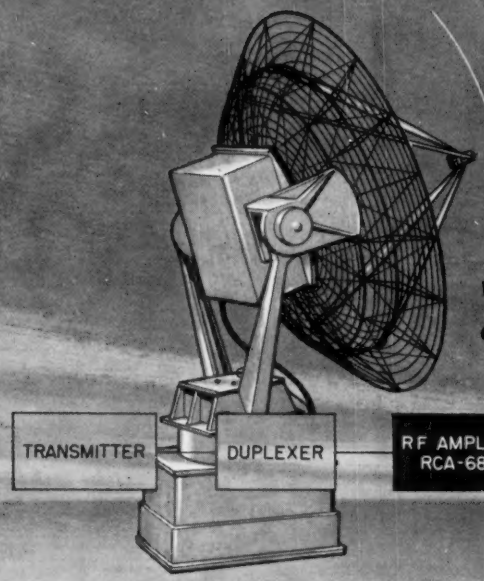
WE SELL DIRECT
Prices are net, FOB Cambridge or West Concord, Mass.

FIRST COMMERCIALLY AVAILABLE

LOW-NOISE TRAVELING-WAVE TUBE



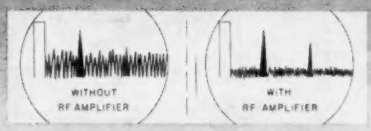
with av. noise figure of 6.5 db over entire 2700-3500 Mc band

- **increases S-band receiver sensitivity**
- **eliminates crystal "burnouts"**

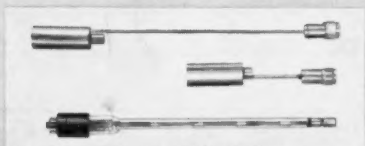
Now in production, RCA-6861 is a major advance in electron-tube design for microwave receivers. It enables—for the first time—the practical application of low-level rf-amplifier stages in radar, scatter-propagation, and other microwave receivers, and if-amplifier stages for millimeter-wave receivers.

The unusually low noise figure of 6.5 db is obtained by the use of an RCA-designed special type of electron gun which deamplifies noise generated in the electron beam.

Sales information on sample units or quantity deliveries is available. Contact your RCA Representative at the RCA District Office nearest you.



Patterns show signal-to-noise ratio at input to S-band receiver's crystal detector with and without a stage of rf amplification. Utilizing RCA-designed-and-developed type 6861 Traveling-Wave Tube, high signal-to-noise ratio and extended range are obtained. In addition, crystal "burnouts" caused by TR-tube leakage are eliminated by the isolation afforded by the rf stage.



Glass portion of RCA-6861 is enclosed with rf-input and rf-output transducers in tubular metal capsule. Transducers are factory-set for optimum tube performance; require no adjustment in the field. Capsule has terminals which fit the standard octal socket.

RCA-6861 DATA	
Heater Voltage	5.0 ±5% volts
Collector Voltage	400 volts
Collector Current	150 μa max.
Magnetic Field*	525 gausses
Noise Figure	6.5 db
Gain	25 db
Frequency Range	2700 to 3500 Mc

*Field supplied by RCA solenoid Dev. No. J-2006, or equivalent.

CIRCLE 464 ON READER-SERVICE CARD FOR MORE INFORMATION

RCA DISTRICT OFFICES

EAST: HUmboldt 5-3900
744 Broad Street
Newark 2, N. J.

MIDWEST: WHitehall 4-2900
Suite 1181
Merchandise Mart Plaza
Chicago 54, Ill.

WEST: RAymond 3-8361
6355 East Washington Boulevard
Los Angeles 22, Calif.

For technical data on RCA-6861, write RCA, Commercial Engineering, Section H16R, Harrison, N.J.

RADIO CORPORATION of AMERICA
TUBE DIVISION HARRISON, N.J.